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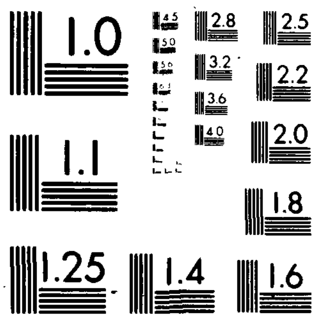

MICROCOPY RESOLUTION TEST CHART

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SVIC NOTES

ANALOGUE COMPUTERS?

I feel it about time to address the topic of the computer revolution and its relation to the shock and vibration community. Simply put, "We've come a long way, baby!"

The United States in particular has pushed the development of the digital computer to almost unimaginable speeds and capacities. The cycle times of the arithmetic processor units are now measured in tens to hundreds of nanoseconds and storage capacities exceed many millions of pieces of information.

Digital computers are used almost exclusively for structural dynamics analysis and computational fluid dynamics. In fact, an entirely new field called computational physics has grown up which owes its existence to the high speed digital computer. The aerospace industry and the U.S. space program can be blamed for much of this rapid development.

The problem as I see it is that U.S. researchers have developed a mind set and a myopic vision which makes them believe that all forms of computation must be done with a digital computer. Engineering students through the U.S. educational system in the last 25 years have come to rely on the power of the digital computer as a matter of course. In fact, the availability of this inexpensive computer time has caused a shift of the skills of recent graduates. It is less the case today that they are required to provide closed form analytical solutions to most problems; many problems are in fact solved with 'canned' finite element programs such as NASTRAN. The results of this are that the skills of the average U.S. analyst in generating closed form solutions have dropped relative to what they were 20 years ago. Another consequence is that the use of analogue computers in the U.S. has fallen to a very low level.

The mind-set becomes apparant when U.S. researchers are confronted with a hard computational problem. The pat answer is that we need to develop a faster, less expensive digital machine with more storage capacity in order to solve the harder problems! The myopia comes about when U.S. researchers fail to look for solutions using analogue or hybrid computers. Japan and other countries have of necessity continued to develop these other methods. It wouldn't hurt to look at their methods with the idea of finding some useful information.

Certain classes of problems are solved very efficiently using analogue/hybrid computers. The types of differential equations which one encounters in formulating solutions to fluid-film bearings problems can be handled well. Shock response spectra calculations are really the solution of a differential equation and are difficult to perform using digital techniques. In fact the most efficient digital solutions for shock response spectra use digital filters which do nothing more than simulate an analogue computer!

Finally, I should mention real time simulation problems, especially those in which many non-linear differential equations are solved simultaneously. Analogue or hybrid computers are used a great deal for these applications, especially in NASA. Simulation 'languages' are available with which one can set up and run dynamics problems on a digital computer. However, it's not an efficient way to solve the problem. Analogue techniques would be better.

In summary I think there should be a resurgence of interest in analogue and hybrid computers in the U.S. The hybrids could in fact look just like a digital computer but the working elements would be analogue. To aid this process U.S. researchers should make a survey of any developments in analogue/hybrid technology made in both the U.S. or other countries with an eye towards taking advantage of them.

J.G. Showalter

EDITORS RATTLE SPACE

TRAINING OF THE VIBRATION ENGINEER

Because the teaching of the theory and practice of vibration engineering is not offered as a formal curriculum in our universities and colleges, vibration engineers must acquire their knowledge informally. Much formal training is available to those who attend graduate school, however, in the mathematics associated with mechanical vibration. One gap in engineering training has to do with using instrumentation and conducting experiments. Even though an undergraduate or graduate program rarely deals with instrumentation, especially electronics, electronics are a fact of life for the mechanical or civil engineer who practices vibration engineering. Sophisticated instrumentation has made the measurement and analysis of machine and structural vibrations practical.

It is important for a mechanical engineer to understand machinery and for a civil engineer to understand structures if they conduct vibration studies or solve vibration problems. But it is also necessary that these engineers know some basic electronics -- otherwise, they will not be successful in taking measurements and analyzing data. In my opinion, electronics should be included in basic mechanical and civil engineering curricula.

I think that universities and colleges place too much emphasis on using the digital computer to conduct mathematical analyses. Although such analyses are important, engineering measurement and analysis of field data using electronics are equally important. The engineer in training has the responsibility of making up this lack of formal training: not a simple matter on a new job.

Therefore, I believe that colleges and universities should become involved in assessing the basic training now required to practice engineering. Perhaps they would discover that a knowledge of basic electronics is essential to mechanical and civil engineers.

R.L.E.

LOCALIZED IMPACT PROBLEMS OF COMPOSITE LAMINATES

N. Takeda and R.L. Sierakowski[1]

Abstract - This article summarizes work on locally impacted composite material problems. The following topics are included: localized impact damage experiments of filament reinforced composite materials, the solution of wave propagation problems based on continuum mechanics models, and Hertzian contact approaches to impact problems.

The localized impact problem of beams and plates made of homogeneous and isotropic elastic materials has been summarized [1, 2]. An equivalent investigation of similar problems for structures of composite materials has been the object of considerable recent research activity. This review summarizes work on composite material problems from three different points of view: localized impact damage experiments, solution of simplified wave propagation problems based on continuum mechanics models, and Hertzian contact approaches to impact problems.

LOCALIZED IMPACT DAMAGE EXPERIMENTS

Locally impacted composite plates were used in some of the early experimental studies dealing with the impact resistance and penetration characteristics of FRCM[2]. Gupta and Davids [3] studied the penetration resistance of fiberglass cloth/polyester plates of varying thickness and density. They fot d a linear relation between energy loss in penetration and thickness, a linear relation between impact energy and plate thickness required to just stop the projectile, and a relation between plate density and stopping thickness. They found that the weight efficiency of fiberglass cloth is greater than that of steel.

Morris and Smith [4] observed noticeable internal damage in fiberglass laminated plates tested at very low impact energy levels without noting any apparent surface damage. They also measured the residual tensile and bending strengths of impacted specimens. The resultant internal damage, delamination, debonding, or fiber breakage significantly reduced strength, particularly in bending.

Additional investigations on the impact resistance of fiberglass/epoxy plates reinforced with wire sheet have been conducted by Wrzesien [5]. The wire reinforcement significantly improved composite impact resistance and provided better damage containment. Plates with apparently good penetration resistance were heavily delaminated, indicating that a considerable amount of impact energy was absorbed by the delamination.

Askins and Schwartz [6] reported that a two-stage failure mode consisting of extensive delamination followed by tensile loading of individual laminas increased energy absorption in composite backup panels for ceramic armor. They conjectured that the tensile loading stage was the major energy absorbing mechanism in their tests but that extensive delamination was needed to prevent plugging of the panel and to permit more of the panel to participate in the impact event and contribute to energy absorption. Test results indicated that for such applications fibers should have low density, high tensile strength, high stiffness, and low interfacial bond strength.

The effects of preload and of ply lay-ups for graphite/epoxy and boron/epoxy laminated plates referenced to composite penetration characteristics, particularly the residual strength and the threshold strength, have been examined [7, 8]. In one case biaxial preloading produced a variety of failure patterns for transverse impacts [7]. Residual strength and threshold strength correlated directly with the fracture toughness of the laminates [8]. The propagation velocities of cracks that initiated from projectile holes were approximately 55 percent of the shear wave velocity for each material tested [8].

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[2] FRCM, Filament Reinforced Composite Materials

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Residual strength studies of advanced composites have been made [9-11]. The residual strength and damage size for metals as well as for boron/epoxy and graphite/epoxy composites have been compared [9], as have the residual and impact fracture strengths of boron/epoxy composites with metals [10]. The residual strength of boron, graphite, and glass/epoxy laminates have been studied and an analogy made between damage inflicted by a single hard particle and by inserting a flaw of known dimensions in a static tensile coupon [11].

Preston and Cook [12] observed the damage of graphite/epoxy cantilever panels caused by the impact of spherical projectiles composed of gelatin, ice, and steel. Steel projectiles had the lowest damage threshold. A Hertzian analysis showed that small steel projectiles were most likely to cause delamination and penetration damage.

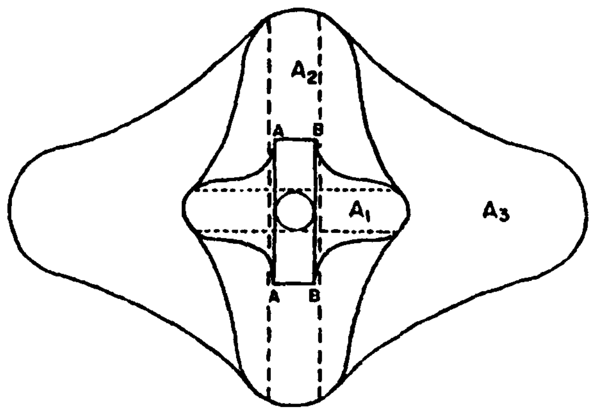
Foreign object impact experiments conducted on glass roving cloth/polyester laminated plates consisting of three laminas showed that, below the perforation speed, the dominant energy absorbing fracture mechanisms were delamination between laminas and debonding between fibers and matrix [13]. It was also shown that the total damaged area and the initial kinetic energy have a linear relation.

Gorham [14] used high-speed photography to examine fracture behavior of fibrous and laminated composite plates. The semitransparency of the materials selected for testing enabled internal failure to be examined photographically. Both commercial and model composite systems were loaded at very high rates of strain by both high-speed water impact and hard body impact. In particular, lamina model experiments suggested the initiation of shear along a lamina interface by waves that produced frontal delamination in the laminates.

Impact tests on full-scale laminated turbine blades have also been carried out by engine manufacturers [15-17]. Impactors used for these studies include gravel, ice, steel, gelatin, and birds.

Experimental studies on failure mechanisms of impacted composite laminated plates [18-26] have been reported during the past several years. Ross and Sierakowski [18] studied the influence of composite constituents, and the geometric arrangement of fibers on the penetration resistance of impacted plates. A comparison of data based on a real density merit rating system showed a favorable energy absorption potential for fiberglass composites. In one series plates tested were fabricated from fiberglass roving continuous filaments impregnated with an epoxy matrix and laid up in 0° - 90° ply configurations. The purpose of the tests was to examine the effect of varying the number of fiber layers in each plate while keeping a constant total number of 15 layers in each plate. It had been anticipated that an alternating crossply arrangement, with one layer in each lamina, would offer greater resistance to perforation than any other arrangement. However, it was shown that a plate with five three-layer laminas or one with three five-layer laminas showed slightly better perforation resistance to normal impacts using blunt-ended impactors.

Close examination of some of the perforated and partly penetrated plates led to the description of a sequential delamination mechanism [19] that appears to account for the good penetration resistance of plates consisting of multilayer laminas. The delamination areas were clearly evident in the semitransparent fiberglass/epoxy plates when a bright light was placed behind the plates.



Schematic of Three Sequential Delaminations; First Generator Strip is Bounded by AA and BB

The schematic diagram shows the damage observed for three delaminated areas, labeled A_1, A_2, A_3. A blunt-ended cylinder of diamter D was used to strike plates with multilayer laminas at moderate speeds; a

shear cut-out was noted first. This circular plug does not necessarily extend all the way through the first lamina. Sequential delamination began when a strip of width D in the first lamina (parallel to the fibers) was pushed forward by the penetrator. This so-called generator strip transversely loads the second lamina and initiates a separation between the first two laminas. The generator strip from the first lamina is bounded by two through-the-thickness shear cracks, marked AA and BB in the diagram. This generator strip lengthens and the delamination area A_1 enlarges until the available energy is insufficient to sustain propagation of the delamination. A new generator strip may form in the second lamina (perpendicular to the first one in the 0° - 90° lay-up plates), thereby initiating a second delamination area A_2 between the second and third laminas. The process is then repeated, and each subsequent delamination covers a larger area than the preceding one.

The dependence of these failure mechanisms on such parameters as fiber type, ply orientation, and matrix-fiber interaction has been investigated [20]. Such diagnostic tests as pull-out tests and low-velocity repeated impact tests were used. The ductile-fiber steel/epoxy systems tested did not display the sequential delamination process; rather, they exhibited an almost symmetrical damage area without significant delamination.

Another series of tests on 0° - 90° fiberglass/epoxy plates was undertaken to examine in detail the mode of progressive failure and the effects of the sequential lay-up arrangement on the development of the generator strip and the sequential delamination mechanism [21]. In particular, the effect of the number of layers in the first and second laminas on the initiation mechanism was discussed.

Analysis of these controlled and ordered lamina tests [22] revealed a linear dependence of the total delamination area obtained on the initial kinetic energy of the impactor at speeds below the critical speed for perforation. The straight line was fitted to the data for plates with five three-layer laminas. The equation of this line was

$$K = 3.5 + 0.315A \quad \text{for } K>3.5J$$

K is the kinetic energy measured in joules; A is the delamination area in cm^2. The apparent fracture surface energy was constant at 1580 J/m^2 (or 0.158 J/cm^2, half the coefficient of 0.315 in the above equation because two surfaces are formed).

Fiberglass plates of the same type as those centrally impacted in early studies, along with fiberglass cloth plates, were subjected to blast loading using a fuel air explosive device [23]. A delamination mechanism again appeared to be the dominant failure mechanism for blast loads below the edge failure load. Delamination began at the plate edges and progressed toward the center of the plate. The total delamination area appeared to be proportional to the amount of plate deflection and the intensity of the applied blast pressure.

Calculations of the elastic response to a simulated impact loading applied as a pyramid-shaped pressure distribution over a square area at the center of the localized impacted plates were made using a DEPROP (Dynamic Elastic-Plastic Response of Plates) computer code; the results were compared with experimental data with some success [24]. Attempts were also made to calculate the location of the maximum shear stress; simple elastic analyses for cylindrical bending of the laminated plates with orthotropic laminas having unequal moduli in tension and compression were used. A summary of these experimental and analytical studies has been reported [25].

Additional experimental studies on the effects of the impactor nose shape and the impactor mass on the fracture behavior have recently been conducted [26]. The details of the fracture including the generator strip, transverse cracks of each lamina, and the delamination have also been investigated using SEM pictures of the sections of the impacted laminate. The delamination crack propagation has been monitored using a high-speed camera; the time history of the elastic flexural wave has been measured by strain gages. These studies show that the observed delamination is caused mainly by the elastic flexural wave.

SOLUTION OF SIMPLIFIED WAVE PROPAGATION PROBLEMS BASED ON CONTINUUM MECHANICS MODELS

Theoretical analyses of wave propagation in transversely impacted composite laminates have been widely discussed [27-37], but only a few experimental investigations have been reported [30, 38].

A laminated plate theory [27] that includes both thickness shear deformation and rotary inertia has been investigated [28]. Several boundary value problems were solved.

A similar laminated plate theory was used to derive the dynamic equations for orthotropic laminated plates [29]. The propagation of flexural waves and the transient response of a rectangular plate to a normal impact were investigated. The effect of transverse shear on the amplitude of the deflection was evaluated in this dynamic study of anisotropic composites.

Chou and Rodini [30] demonstrated the accuracy of the laminated plate theory in transient wave propagation problems. They compared experimental measurements with theoretical calculations. The experimental program involved impacting the edge of a specimen plate with a striker plate. Each specimen was subjected to two separate impact loadings: an in-plane impact and a so-called shear-bending impact. The analytical phase consisted of solving the Whitney and Pagano equations by the method of characteristics.

The adequacy of the lamination theory has been demonstrated in a comparison of the more exact orthotropic elastic solution with the lamination theory solution [31]. The fast Fourier transform (FFT) technique was used.

Other analytical investigations on transient wave propagation have been reported [32-36]. Moon investigated the shape of wave fronts of an infinite laminated plate subjected to both transverse and central impact loads. The mathematical model used for the plate element analyzed was based on the effective modulus theory for composites and Mindlin's theory for plates; in the latter displacement is expanded in the thickness variable using Legendre polynomials. The velocity and wave surfaces were described as functions of the lay-up angles for the graphite/epoxy plates examined.

Moon [33, 34] also studied the one-dimensional stress and displacement distribution induced in the same model by impact line forces; he used the fast Fourier transform (FFT) technique. He reported [34, 35] a two-dimensional analysis that results in five two-dimensional stress waves. Three of the waves are flexural and two involve in-plane extensional strains. Results obtained using this analysis indicate that the points of maximum stress travel along the fiber directions. He showed that, for $\pm$ 15 degree angle-ply lay-ups, lower flexural stresses are generated than for 0, $\pm$30, and $\pm$45 degree cases.

Kim and Moon [36] recently modeled a multilayer composite plate as a number of identical anisotropic layers. They applied Mindlin's theory to each layer and obtained a set of difference-differential equations of motion; the interlaminar stresses and displacements were used as explicit variables. Propagation of waves through the plate thickness was also examined. This problem was then extended to examining the effect of introducing damping layers between two elastic layers.

Kubo and Nelson [37] have presented an analytical study of the two-dimensional (plane-strain) response of an elastic laminated plate; they used a finite element/normal mode technique. The physical behavior of the plate was represented along its in-plane length in the form of a Fourier series. The behavior of the plate in the thickness direction was modeled by a sufficiently large number of generalized coordinates to capture quantitatively the propagation and dispersion of stress waves due to a surface impact. This technique produced both high and low frequency information for both long and short wavelengths with respect to the plate thickness.

Experimental investigations have been conducted [38] to study the wave propagation characteristics, transient strains, and residual properties of unidirectional and angle-ply boron/epoxy and graphite/epoxy laminates impacted with silicon rubber projectiles at velocities up to 250 ms^{-1}. Strain signals recorded using surface and embedded strain gages were monitored and analyzed to determine the wave types, wave propagation velocities, peak strains, strain rates, and attenuation characteristics. The predominant wave form was a flexural one propagating at different velocities in different in-plane directions within the impacted plate.

HERTZIAN CONTACT APPROACHES TO IMPACT PROBLEMS

In the wave propagation studies described in the preceding section, impulsive forces introduced in

the laminates were assumed to be known. However, in reality, loading is the result of an impact generated between the projected object and the plate and should be evaluated. The classic Hertzian contact theory of impact has long been applied to this localized impact problem to evaluate the contact force, the dynamic response of the plate, and the energy transfer.

The Hertzian contact theory of impact has been extended to anisotropic half-space bodies [39, 40]. The contact region has been shown to be elliptic, deviating slightly from that of a circle [39].

A simple model for estimating the contact time for isotropic spheres impacting composites has been suggested [34]. The model assumes a circular contact area. Dependence of contact time T and peak pressure P_o on the impact velocity V was of the form

$$T = 1/V^{1/5}, P_o = V^{2/5}$$

Hertzian contact theory has also been used to study the dynamic response to impact by spherical impactors, of both semi-infinite composite laminates and finite laminated plates. Three major steps were used to formulate a solution: time-dependent surface pressure distribution under the impactor, time-dependent internal stresses in the target caused by surface pressure, and failure modes in the target caused by internal stresses. To verify predictions of failure modes, ball-drop tests were conducted on circular laminated plates [42]; various fiber-resin combinations, fiber lay-ups, and stacking sequences were used. The visible damage used in the analysis consisted of observed transverse cracks on the back face of the impacted plates.

As mentioned earlier, Preston and Cook [12] also analyzed the simple Hertzian contact problem for cantilever laminates. An interesting aspect of this analysis was that multiple impacts were predicted due to the combination of vibratory modes and the local elastic deformation occurring.

A more rigorous solution for the response analysis of laminates has been presented by Sun and Chattopadhyay [43]. They used a method proposed by Timoshenko to derive a nonlinear integral equation. The equation was used to obtain the contact force and the resultant dynamic response of the simply supported laminated plate subjected to the central impact of a mass under initial stress. The plate equations developed by Whitney and Pagano [28], which include transverse shear deformation, were used as the governing equations. The energy transferred from the mass to the plate was obtained using this analysis.

Sun [44] developed a higher order beam finite element model in conjunction with the Hertzian contact law to determine the total energy imparted from the projectile to the beam and the damage energy that causes local damage in the laminated beam subjected to impact of hard projectiles. Linear elastic analysis was used up to the maximum contact force point with subsequent unloading assumed as in rigid plasticity.

CONCLUDING REMARKS

A survey of localized impact problems of composite materials has been outlined. At the present time, knowledge of the impact resistance of FRCM is scarce; better understanding of impact damage levels is necessary for FRCM to be used under a variety of impact loading conditions.

On the basis of the above review, further studies are recommended in each of the categories mentioned. Static bending tests on non-impacted plates and on strips cut from the plates should be conducted for comparison with the impact tests. Particularly necessary is information comparing the delamination occurring and the fracture surface energies for the various FRCM plates.

Tensile and flexural waves before failure could be observed using surface-mounted strain gages, those embedded inside the plates, or by use of the Moiré fringe technique. The time sequence of events in the delamination process in semitransparent plates can be recorded by a high-speed camera to verify how much of the process is sequential rather than simultaneous. In opaque plates electrical paths that would be broken by the propagating delamination cracks might be fabricated into the plates to monitor the sequence of events. Because a localized impact failure involves different failure modes, they must be separated to estimate each contribution to the total fracture energy. For that purpose, plates with built-in defects such as shear cutouts and delaminations

could be tested statically and under impact loading conditions.

Analysis to accommodate multilayer configuration involving interlaminar shear and normal stresses should also be conducted. One such method has been suggested [36]. A simplified model of the propagating delamination crack in terms of fracture mechanics methods should also be studied. Finally, the effects of multiple contacts should be more thoroughly investigated in order to clarify the conditions necessary for multiple contacts and the quantity of projectile energy that can be transferred during each contact time.

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains an article about equivalence techniques for vibration testing.

Dr. H.S. Blanks of the School of Electrical Engineering, University of New South Wales, Australia, has written a paper on techniques relevant to the equivalence between vibration tests and service vibration experience. The paper is intended to convey a picture of the state of the art.

EQUIVALENCE TECHNIQUES FOR VIBRATION TESTING

H.S. Blanks*

Abstract - This survey considers techniques relevant to the equivalence between vibration tests and service vibration experience. It is intended to convey a picture of the state of the art; most of the references were published after 1975.

Equivalence techniques in vibration testing refer to tests that correlate with field vibration exposure or with other vibration tests. The basis for correlation ranges from damage, time to failure, magnitude of specific vibration or stress parameters, and equipment performance to physiological effects and psychological response. Motivations for the development of such techniques include simplified and accelerated testing.

Several surveys and books relevant to equivalence techniques are available [1-8]. Survey papers are also available on modal testing [9-11]. Not included in the present survey are techniques aimed at determining the dynamic response of structures under one type of excitation from tests conducted with a different type.

SIMULATION OF FIELD VIBRATION

For reliability testing the laboratory vibration must produce the same type of damage or malfunction, and the same (or correlated) failure rate or time to failure, as the field or service vibration [12-16]. Comparison of field and laboratory data sometimes requires the computer acquisition and processing of multichannel data on field and laboratory stresses or strains at critical points [15, 17, 18]; e.g., to adjust laboratory multipoint excitation levels until an optimum distribution of cumulative-damage equivalence is achieved for all strain-gauge locations in a vehicle and test rig [15]. Because it is not always possible or economical to determine directly actual vibration under all service conditions, field forces themselves must sometimes be simulated.

Apart from extensive ground simulation of the vibration of aerospace structures and equipment, vibration simulation has been used to study vehicle behavior [12, 15, 19-27], offshore structures [28-30], and seismic phenomena [31-33].

CHOICE OF TEST TYPE AND SPECIFICATION

The degree of equivalence varies, depending on the technique used -- fixed frequency constant amplitude, single frequency sweep, fixed multi-frequency, block-program (with or without block sequence randomizing), randomized sequence of cycles or half-cycles of programmed amplitude, broadband random, narrow-band random, swept narrow-band random, processed service history, and repetitive shock loadings. Terms relevant to block-programs in fatigue testing have been defined [34], and diagrams to illustrate the translation of a typical service vibration into block programs and randomized cycle and half-cycle loadings have been given. A detailed survey of the development of randomized and random testing up to 1968 is available [1].

The type of test used depends on application, economic considerations, accuracy required, and purpose. Thus, as evidenced by MIL-STD-781C, "Reliability Qualification and Production Acceptance Tests, Exponential Distribution," in agreement with a Grumman report [35], broadband random excitation -- e.g., 0.04 G^2/Hz from 80 Hz to 400 Hz, with 3 dB/octave roll-off to 20 Hz and 2000 Hz -- is considered the most effective screening and reliability vibration test for jet aircraft avionic equipment. The choice between impact, swept sine, and white noise

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random excitations has been discussed [36] on the basis of vibration response rather than endurance testing. Fixed single-frequency resonant, swept sinusoidal, single sub-resonant frequency, and bumping have been compared for endurance testing [37]; for high-Q components bumping permits a faster test than swept frequency, but fixed-frequency resonant is not practical because of f_n scatter and the drop of f_n with accumulating damage.

Random testing a problem requires the specification of a power density spectrum (PDS) envelope that is conservative but does not grossly overtest. Some indices of conservatism, a confidence criterion, and a method for calculating the probability of undertest have been published [38]. Random vibration test criteria of aircraft equipment, based on vibration induced by turbulent airflow and jet engine exhaust noise have been described [39, 40]. Such cheaper alternatives to true random vibration as pneumatic and mechanical shakers have been suggested [41]. An optimum laboratory random test program constrained to only two or three rms levels has been determined [42]; it is minimally dependent on the value of the life-versus-acceleration-level power-law exponent.

Several standard test programs have been developed with the purpose of covering in one program all of many vibrational circumstances that might be encountered in service. One such standardized load sequence for transport aircraft is called TWIST [43]; another, FALSTAFF, for fighter aircraft [44, 45] is based on 200 flight-by-flight histories of five fighter aircraft in three different missions. The data for FALSTAFF were reduced to an average of about 80 cycles per flight and consolidated into a Markov matrix of peak-trough, trough-peak transition probabilities. A standard random load sequence for general application, namely a stationary Gaussian process with a crest-factor 5.25652 corresponding to 10^6 positive-going zero crossing per sequence and an irregularity factor of 0.7 has been proposed [46].

EQUIVALENCE BASED ON FATIGUE DAMAGE

Most vibration testing has been in the context of fatigue damage, including fatigue at high temperature [4, 5]. The S-N curve and the relative damage rule based on Miner's sequence-independent n_i/N_i summation remain the most common bases for deriving, explaining, and utilizing testing equivalences. Many attempts have been made to use crack-growth models [47-50]. The S-N curve is generally stress vs cycles, but strain vs cycles are also used, particularly in the low-cycle fatigue region [51, 52]. The effect of mean stress has been discussed [53], and both mean stress and plastic deformation have been incorporated by a method of stress amplitude transformation on the basis of equal local stress-strain hysteresis [54]. When $\Sigma n_i/N_i$ is calculated for nonconstant-amplitude vibration, the S-N curve is usually extended below the constant-amplitude fatigue limit, either by direct extension of the logS-logN line [55, 56] or by an extension of reduced slope [54] -- e.g., changing the slope from 1/b to 1/(2b-1). The quantity b is a function of surface condition, typically three or four for a notched specimen, six for a machined one, and ten for polished ones. The quantity b has also been reduced when the S-N curve is applied to narrowband random vibration [57]. The distributive nature of the S-N curve has been treated quantitatively [50, 58, 59].

Miner's Rule has been widely discussed. Its incorrectness arises largely from the distinctness of crack initiation and propagation mechanisms, strain-hardening effects, and the effects of localized residual stresses. A procedure is available that takes into account stress and sequence effects [60]. Corrections for stress range, initial flaw (crack) length, a geometrical factor, and fracture toughness have been made [50, 61]. The rule has been considered valid in a probabilistic sense [62] and a literature survey into the distribution of $\Sigma n_i/N_i$ at failure has been done [63]. A stress-dependent nonlinear damage vs n/N relation has also been used to explain some observed stress sequence effects [56].

ACCELERATED TESTING OF VIBRATION FATIGUE

Accelerated testing can be achieved by increasing stress level, increasing drive-signal frequency or loading rate, and deleting the non-damaging parts of a vibration history.

The expressions for the life vs stress power-law exponent [2] have been extended and experimentally confirmed [64]; attention is drawn to the dependence of the exponent value on whether it is the failing component or whether its support is reso-

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nating. Assuming high stress the broadband random exponent expression [2] has been confirmed for air-to-air guided missiles [65]; it has been noted [55, 65] that atypical failures occur if the stress level is increased too much. The life-stress power law has been used to develop an accelerated test method in which excitation is increased exponentially with time [66]; the method, which is a fast way to determine the power-law exponent, compresses scatter of failure times and requires less prior knowledge of the vibration resistance of the test item than does typical level-up testing.

One method of acceleration is to drive the shaker fast. A method for compensating a drive signal for the dynamic response of a test rig has been described for a computer-driven machine [67]. A method for using a computed modification of the original Markov transition-probability matrix is included [67].

The Effective Random Peak method, by which the computer deletes ineffective peaks from the actual service history has been described [55]. Acceleration factors up to about 400 are claimed. Small-cycle omission has been investigated [68]; it was concluded that, if high load or strain levels are present, great caution is needed in omitting small levels. The damage contribution of small-level cycles in block-programs in the presence of high-level cycles has also been shown elsewhere [56].

CONVERSION OF RANDOM HISTORIES TO BLOCK PROGRAMS

Cumulative damage is generally assessed in terms of $\Sigma n_i/N_i$. Failure prediction and the estimation of damage during testing thus requires the development of equivalent block programs so that actual histories can be translated into equivalent mixes of simple cycles. The many cycle counting methods have been critically reviewed [69-71]. The level-crossing counting method has been widely used [15, 71], but the rainflow method [72, 73] provides the best equivalence. The effect of ignoring or deleting small cycles on different histories, using the mean-range and rainflow counting methods, has been studied [73]. The mean-range method requires a threshold to reduce the false break-up of large swings by intermediate reversals. For all gating levels the mean-range method was nonconservative relative to rainflow counting. Various cycle-counting algorithms have been developed, including those for rainflow counting [74, 75] and for small-cycle filtering [76].

The effects of altering the stress-level spectrum have been widely studied. References for the period 1971-1977 [68] conclude that sub-fatigue-limit cycles can usually be disregarded if the load levels of the remainder of the history are not too large. High and low stress cycles have been added to test blocks for notched specimens [56]; an increase in the relative frequency of infrequent high stresses increased $\Sigma n_i/N_i$ at failure but had only a minor effect on the number of blocks to failure. Insertion of a few near-yield cycles into blocks containing many medium and sub-fatigue-limit cycles substantially increased $\Sigma n_i/N_i$ at failure and life [77]; for a larger number of such inserted cycles the improvement was less. Omission of the frequent sub-fatigue-limit cycles caused life improvement similar to the maximum obtainable through high-stress cycle insertion.

The effects of stress amplitude sequence are complex. Several phenomena are involved; e.g., the phases of crack initiation and growth, strain hardening, and residual compressive stresses at the crack tip. With regard to sequence effects on crack growth, block-program tests might be unconservative relative to the service history [78]. The difference between two-level high-to-low and low-to-high reliability in terms of the distributive nature of the S-N curve has been explained [58]. Crack-growth mechanics have been used to conclude that, for two-level loads and an initially flawed specimen, high-to-low gives larger $\Sigma n_i/N_i$ at failure than low-to-high [50, 61]. This has been called the reversed effect, due to the beneficial influence of compressive residual stress, and $(\Sigma n_i/N_i)_{L\text{-}H} > (\Sigma n_i/N_i)_{H\text{-}L}$ has been called the normal effect and is explained by nonlinear, stress-dependent damage-versus-n/N relationships [56, 79]. Randomizing the block sequence appears wise in light of the various sequence-related phenomena.

DIGITAL CONTROL AND RANDOM-SIGNAL SYNTHESIS

A comprehensive overview of digital control in vibration testing has been published [80]. Digitally-controlled random vibration testing has been described [81], as has software development to com-

bine shock, random, and sinusoidal tests in close sequence for real-time mission simulation [82].

Computer synthesis of a random signal is either by the generation of a signal with a specified PDS, generally assuming a Gaussian amplitude distribution, or by one- or two-dimensional random walks, the latter in accordance with a peak-trough, trough-peak transition probability matrix [67, 83]. A signal with a specified PDS can be generated by digital filtering of white noise. The use of a transition matrix for signal synthesis can be misleading because the transitions in actual histories are not Markov processes. It is therefore not legitimate to eliminate small cycles by merely setting the corresponding elements in the matrix equal to zero [67]. Conditions under which the matrix method of generating a valid trough-peak sequence can be used have been described [84].

SCALING AND MODELING

Substantial increases in the testing of scale models have been predicted [85]. The equivalence between the behavior of actual structures and scale models is too large a subject for this survey, however. Response analysis using scale models is more feasible than reliability or endurance testing for which the reproduction of equivalent stress raisers is a major problem. Attention has been drawn to problems concerning mean stresses in civil engineering structures [86]. A comprehensive text on scale-modeling is available [87]. Experimental methods for determining the vibration response of structures from testing scale models have been described [88].

EQUIVALENCES NOT BASED ON FATIGUE DAMAGE

It has been difficult to establish equivalence techniques relevant to wear and wear-out [3]. The resemblance of wear-out failure curves for electronic equipment and fatigue S-N curves has been pointed out [7]. Fretting-wear degradation of electric contacts is an important phenomenon [89-91]. The effect of movement parallel to the interface is generally not predictable [91]. An S-N type of curve between normal load and number of cycles to give a certain scar width has been reported [92]. The combined effect of lateral and normal vibrations is much stronger than that of either individually [93].

Creep under random loading has been treated on the basis of a stress-life power law and a linear cumulative damage model [94]. Combination of the power law and the model would permit equivalence techniques to be developed.

Work on malfunction-based equivalences was done in the early 1960s, but lack of useful results discouraged further effort. References are available [3]. Statistical studies of such first passage malfunction as collision at the first passage of vibration amplitude above a certain value, relevant to random vibration, have been undertaken [95-97].

An interesting area is that of equivalences based on such human factors as comfort, task proficiency, and health. The relevant variables include vibration frequency, rms acceleration, peak maxima, direction, exposure duration, and the presence of such phenomena as noise. ISO 2631 [98] is a guide for evaluating the effects of whole-body vibration. The hand-arm system has also been studied [99, 100], as have standards for whole-body vibration levels [101]. Duration effects as reported in ISO 2631 have been disputed [102]. The subjective equivalence of sinusoidal and random whole-body vibration has been discussed [103], as has that of noise and whole-body vibration [104]. Experiments to allow comparison of the effects of sinusoidal and non-sinusoidal, translational, and angular vibration have been reported [105]. The maxima of the stochastic process, weighted for frequency sensitivity according to ISO 2631, have been considered the most relevant measure of ride comfort [106].

Noise is closely associated with vibration, and the human effects have been studied relevant to equivalence methodology, namely the development of composite measures of noise on the basis of hearing damage [107] and other criteria [108-110]. A single-number rating for sound insulation has been discussed [111].

ENVIRONMENTAL EQUIVALENCE

The effects of the environment -- temperature, gaseous composition, humidity, air pressure -- on fatigue life have been studied [112-114]. High temperature damage is usually related to crack growth. Therefore, in fatigue testing and wear testing [115] it is impor-

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tant that the environments be equivalent. Many of the effects are frequency dependent; that is, the effect decreases with increasing frequency [112]. Combined environmental reliability testing (CERT) is being used increasingly to provide a controlled combination of environments that parallel actual profiles [116, 117].

VIBRATION EXCITATION

The achievement of equivalence can be affected by the type of shaker and the excitation method used. Comparative information on electromagnetic, electohydraulic, mechanical, and pneumatic shakers and on acoustic excitation is available [7, 16, 41, 118-121]. It has been noted that mechanical and pneumatic shaker approaches to MIL-STD-781C random testing produce multi-frequency complex vibration and not true random vibration [41]. High-frequency aircraft vibrations are transmitted acoustically, not structurally; thus high-frequency testing of avionic and missile equipment should be acoustically excited [120]. Some sections of MIL-STD-810C relate vibration cut-off frequency to item size and weight. Acoustic high-frequency excitation has been recommended for large items; the complexity of resonance response when specimen dimensions approach 0.25 the wavelength of structurally transmitted vibration was also discussed [121]. The development of acoustic test criteria, inducing random vibration that closely simulates the service environment at frequencies above 200 Hz without the need to account for structural transmissibility characteristics, has been described [122]. Details of an acoustically driven shaker table for MIL-STD-781C random testing (not to be confused with acoustic excitation of the specimen being tested) are available [123].

FIXTURES AND MECHANICAL IMPEDANCE EQUIVALENCE

The importance of a correct supporting fixture has been discussed [3, 124-126]. The conventional stipulation is for a rigid fixture; the natural frequency of the fixture should be high compared to the test frequency -- at least three times greater. Useful guidance for such fixture design and assessment is available [124, 125]. However, lack of mechanical impedance equivalence between the test fixture and the actual service support can cause test non-equivalence because the dynamic behavior of the specimen changes [3]. Use of a rigid fixture can overtest the specimen, particularly if the test-specification PDS is an envelope of sets of field data. Force input near the resonance of a system can vary considerably, depending on exciter mass and stiffness, even when the electromagnetic shaker input current is constant [127]. Methods for tackling the problems caused by non-equivalence of field support mechanical impedance and of the test rig include controlling the excitation on the basis of local dynamic responses of the specimen [3]. A review of the literature on mechanical impedance analysis is available [128]. Acoustic excitation permits simple fixturing, with multi-axis excitation [16]. A substantial list of pre-1970 references for acoustic testing of aerospace hardware is available [3].

CONCLUSION

Fatigue has been the predominant failure mechanism considered in the vibration literature; useful equivalence techniques have been developed. With regard to wear-out and equipment malfunction the situation is much less satisfactory. It is important to realize that a technique that produces equivalence with respect to one failure mechanism will probably not provide equivalence for another.

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BOOK REVIEWS

DETONATION

W. Fickett and W.C. Davis
University of California Press
Berkeley and Los Angeles, CA, 1979

This book gives a primarily theoretical treatment of detonation in homogeneous fluids. Much of the book deals with analysis of the partial differential equations (Euler's or Navier-Stokes') describing the flow, with attention to the topology of the solutions, especially the critical points. Steady solutions and alternate solutions when the steady solution is unstable are the focus. Specific examples are given along with the general solutions. A polytropic gas equation of state is often used.

CJ and ZND models are treated first. A discussion of the adequacy of the models in comparison with experiments is given for gases, liquids, and solids. In *unsupported detonations* in gases, for example, the pressure at the state point of complete reaction is 10% to 15% below the CJ value.

Flows with different reaction mechanisms are considered. Cases of one or two reactions are treated, reversible or irreversible, exothermic or endothermic, mole change or none, transport effects allowed or not. In addition to the normal CJ detonation there can be other solutions; i.e., weak or eigenvalue detonations. The piston velocity at the rear boundary determines the solution type. A good deal of the original work in this area was done by J. von Neumann, H. Bethe, and E. Teller during World War II. Significant subsequent work was also done by W. Wood and J. Erpenbeck.

Steady solutions in plane flow for a given rear boundary condition may not be unique. Some solutions are time dependent in an oscillatory manner, as well as three-dimensional. The authors first examine the hydrodynamic stability of the plane solution and then review approaches to finding the time-dependent solution. Finite difference calculations in condensed explosives have been done and show large-amplitude oscillations where the peak pressure can be twice as large as the steady solution value.

The last chapter describes experimental observations of multidimensional structure of nominally plane detonation waves. Transverse waves run laterally behind the front. The collision of transverse waves forms Mach stems; a regular cellular structure can form behind the front. This has been observed in solids, liquids, and gases.

The book is well written and edited and contains many helpful illustrations. However, an axiomatic approach might have made the thermodynamic discussions more transparent. Knowledge of partial differential equations and their solution topology is required for access to some of the material. It should be a durable book in the field of detonation science. I recommend it highly to practitioners in this field.

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FINITE ELEMENTS IN NONLINEAR MECHANICS

Vol. 1, Edited by P.G. Bergan, et al
Tapir Publishers, Trondheim, 1978

The two-volume set contains papers presented at the International Conference on Finite Elements in Nonlinear Solid and Structural Mechanics, held at Geilo, Norway, August 29 - September 1, 1977. The 20 papers in Volume 1 are grouped under three headings: variational formulations, material nonlinearities, and large displacements and instabilities.

The variational formulation papers emphasize formulations other than the familiar one of assumed displacement fields. Atluri and Murakawa develop two

stress-hybrid models for finite deformations. An elastic sheet serves as a numerical example. Nyssen and Beckers develop a three-field variational principle for elastic-plastic problems. They solve a beam problem with an equilibrium element. Samuelsson and Fröier review recent formulations for plasticity. Sander and Carnoy develop equilibrium and mixed formulations in stability analysis and solve plate problems. Papers by Horrigmoe and Eidsheim and by Barnard and Sharman develop an elastic-plastic hybrid stress model. Both papers apply the theories to plane problems and to plates.

In the section on material nonlinearities Bazant discusses alternative theories of plasticity. Sorensen et al apply endochronic theory to reinforced concrete, using displacement-based elements. Axelsson proposes a new strain-hardening rule. Nemat-Nasser and Taya consider and apply formulations suited to the analysis of large-strain ductile fracture.

The last heading is large displacements and instabilities. Gallagher reviews formulations for geometrically nonlinear shell analysis. Krakeland develops and applies a method for combined geometric and material nonlinearities in shells. Wennerström attacks the same problem with flat elements. Matsui and Matsuoka study geometrically nonlinear buckling of circular cylindrical shell roofs. Frey and Cescotto explain the proper formulation of the total Lagrangian method and give numerical examples that involve displacement-dependent loads. Allman proposes a theory and solution procedure for geometrically nonlinear plate bending. Crisfield and Puthli discuss how to reduce the cost of plastic collapse analyses of steel plated structures. Yamada et al attempt to unify the theories of finite strain and material nonlinearity. Tvergaard studies plastic necking instabilities. Casciaro and Aristodemo present a perturbation method for geometrically nonlinear analysis.

This volume will be more useful to academicians and theoreticians than to practitioners. Most of the papers emphasize theory rather than tools of immediate practical value. The mathematics is usually in indicial notation, which will be difficult for engineers lacking a strong theoretical background. The notation is scarcely surprising, however, as nonlinear problems tend to be varied and complicated.

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STRUCTURAL MECHANICS SOFTWARE SERIES

Vol. I, Edited by N. Perrone and W. Pilkey
University of Virginia Press
Charlottesville, VA, 1978

Previous volumes by Pilkey describe various phases of structural mechanic programs, providing the analyst with descriptions of computer programs in thin shells, rotor-bearing systems, plastic analysis, nonlinear continua, torsional vibration systems, and other structural mechanics topics. The present volume could be considered a follow-up because it describes available software – libraries of programs that are readily available on time-sharing and batch programs.

The book consists of two parts. Part I discusses a software series library of computer programs; Part II considers reviews and summaries of available programs. The seven major programs of Part I are outlined in the following paragraphs.

BOSOR 4 is a powerful finite difference program for determining the stress, buckling, and vibration of complex shells of revolutions. This program has undergone intensive development under the direction of Dr. D. Bushnell. It includes segmented, ring-stiffened branched shells of revolution. They can contain meridional geometrics, wall constructions, ring reinforcements, and various types of loading. A brief discussion of the formulation and types of problems analyzed by the program is followed by an appendix. The appendix explains in detail the input cards for running the program including a section on possible pitfalls and recommended solutions. It is a very well organized section and merits reading by individuals not using the program.

GIFTS 4 employs the finite element method and is on a time-sharing system. The versatile program features model generation, display, editing, display of displacement and stress results, static analysis employing a complete basic library of elements for both two dimensions (beams, trusses, and frames) and three dimensions (trusses, frames, and shells). Substructuring, free vibration analysis, and transient analysis employing the Houbolt scheme are given.

Higher order plate elements and beam elements are also included.

Interactive and Data Mode Preprocessor for SAP is the next program. Lack of a data input preprocessor in the original SAP program is a shortcoming of the SAP IV Program. The program PEMSAP prepares the input data for the University of Michigan version (MSAP) and its graphic partner (MSAPLOT). The program has modal point and element mesh generations as well as data mode operation. It is a powerful tool for three-dimensional analysis.

The TOTAL program is an interactive graphic system for two-dimensional analysis of linear elastic solids. Its 28 versatile pre-and-post processing routines are linked to an elementary finite element solution scheme. This program is design-oriented and makes liberal use of graphics for both input and output results. After initial orientation the analyst can employ the program with few pitfalls. It lacks higher order two-dimensional elements and is void of three-dimensional (brick) elements, however.

The BEAM program is used to study static, stability, dynamic response of beams. It is one of a family of computer programs that can be used in structural and mechanical systems. The transfer matrix method is the basis of the program. A number of sample problems illustrate its use.

Cross-sectional properties and stresses of a bar can be calculated with the BEAM STRESS program, which is a member of the BEAM family of programs. The program contains a bandwidth minimizer and many sample problems.

Flexural unbalanced response and critical speed of a rotating shaft with no cross-coupling coefficients in the bearings are the basis of the SHAFT program. For unbalance problems, it calculates the component and resultant deflection, slope, bending moment, shear force, and corresponding phase angle along the shaft. The shaft can be modeled as lumped or continuous mass segments with foundations, and can contain any combination of boundary conditions and distribution of unbalanced masses. Shear deformation and rotary vibration can be included. The program is a member of the BEAM family and utilizes the transfer matrix approach. The program input is well explained in the book, which contains a number of illustrative examples.

The reviewer considers the last three programs good for design analysis provided the user adheres to the restrictions stated in the program.

Part II of the book reviews and summarizes available programs. The initial chapter discusses computer-aided building design. A number of small programs capable of designing one type of component are given. Design of an entire building is illustrated by STRUDL. Other programs consider iteration between analysis and design; optimization; design; and analysis of plastic structures, graphics, and printed and plotted displays. The discussion of interactive graphics and design of buildings is brief but informative.

The second paper considers curved girder bridge systems. At one time the design of curved sections required a large number of calculations; approximations were often made. The present curved girder programs utilize finite elements and can handle 800 members and 500 joints. The book contains descriptions of the programs, types of computer used, and computer language needed.

Symbolic and algebraic manipulation languages and their applications in mechanics are the next topic. The languages blend standard numerical procedures and the more elegant analytic methods. Automated formula manipulation is probably the most effective solution. The most prominent programs of this type are MACSYMA, SCRATCHPAD (extremely versatile), and FORMAC 73 (most versatile).

The concluding papers have to do with floor analysis and design (wood and prestressed concrete) and simulators. A number of programs are described that can be applied to problem solutions. The various chapters and tables provide detailed discussions of the contents, programming language, and computer for which each program is used.

The reviewer highly recommends this manual because it provides insight into the various programs, their contents, and usage. It is a dandy reference book and should be worth the nominal cost to the prospective program seeker and user.

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General Electric Company
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Schenectady, New York 12345

SHORT COURSES

AUGUST

FINITE ELEMENT ANALYSIS IN FLUID DYNAMICS

Dates: August 4-8, 1980
Place: Knoxville, Tennessee
Objective: This course is designed to familiarize the engineer/scientist with the basic concepts and practice of finite element methodology; to detail step-by-step numerical solutions for elementary but highly informative ideal flows; to extend these developments to nonlinear problems, building directly upon introductory concepts; to expose the important aspects of the mathematical theory and make detailed comparison to conventional procedures; to expand applications to turbulent and compressible flows over a range of Mach and Reynolds numbers; and to introduce and correlate the newest developments including tensor products, optimal control, constrained optimization.

Contact: Eunice Hinkle, Department of Engineering Science and Mechanics, University of Tennessee, 317 Perkins Hall, Knoxville, TN 37916 - (615) 974-2171.

NOISE ANALYSIS

Dates: August 6-7, 1980
Place: Cincinnati, Ohio
Objective: This seminar will provide engineers concerned with noise analysis and control an introduction to the most current technology in this area. The session will be dedicated to presenting the latest noise analysis procedures, and the various noise control measures which can be employed, primarily related to product noise. Topics discussed will include: physical acoustics, psycho-acoustics, time series analysis, source identification, structural frequency response, noise control, absorption, barriers, isolation, stiffening, and damping.

Contact: Mrs. Gayle Lyons, SDRC Seminar Coordinator, Structural Dynamics Research Corp., 2000 Eastman Drive, Milford, OH 45150 - (513) 576-2594.

MACHINERY VIBRATION ANALYSIS SEMINARS

Dates: August 12-13, 1980
Place: Sheraton Inn-Newark Airport, NJ
Dates: October 1-2, 1980
Place: Houston, Texas
Objective: These two day seminars on machinery vibration analysis will be devoted to the diagnosis and correction of field vibration problems. The material is aimed at field engineers. The sessions will include lectures on the following topics: basic vibrations; critical speeds; resonance; torsional vibrations; instrumentation, including transducers, recorders, analyzers, and plotters; calibration; balancing and vibration control; identification of unbalance, misalignment, bent shafts, looseness, cavitation, and rubs; advanced diagnostic techniques; identification of defects in gears and antifriction bearings by spectrum analysis; and correction of structural foundation problems.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

FATIGUE ANALYSIS

Dates: August 13-14, 1980
Place: San Diego, California
Dates: September 10-11, 1980
Place: Cincinnati, Ohio
Objective: The growing understanding of the important factors in the fatigue failure process coupled with the accumulation of new, correctly obtained, fatigue test data and material property and behavior data, has led to the practical application of fatigue analysis methods. The vast improvements in stress analysis, both computerized design analysis (finite element methods, etc.) and experimental testing techniques (digital Fourier analysis, cycle counting

methods, etc.) have enabled engineers and designers to get a more fundamental understanding of fatigue. The seminar will address the topics of cyclic stress-strain behavior of metals, fatigue properties of metals and cumulative damage procedures.

Contact: Mrs. Gayle Lyons, SDRC Seminar Coordinator, Structural Dynamics Research Corp., 2000 Eastman Drive, Milford, OH 45150 - (513) 576-2594.

PYROTECHNICS AND EXPLOSIVES

Dates: August 18-22, 1980
Place: Philadelphia, Pennsylvania
Objective: The seminar combines the highlights of 'Pyrotechnics and Solid State Chemistry," given the last eleven summers, and "Explosives and Explosive Devices" that made its successful appearance nine years ago. Similar to previous courses, the seminar will be practical so as to serve those working in the field. Presentation of theory is restricted to that necessary for an understanding of basic principles and successful application to the field. The seminar will be welcomed both by newcomers to the field as well as by experienced men who wish to brush up on latest developments. Coverage emphasizes recent effort, student problems, new techniques, and applications. The prerequisite for this seminar is a bachelor of science degree in engineering or equivalent.

Contact: Mr. E.E. Hannum, Registrar, The Franklin Research Center, Philadelphia, PA 19103 - (215) 448-1236/1395.

HIGH-SPEED COMPUTATION: VECTOR PROCESSING

Dates: August 18-22, 1980
Place: University of Michigan
Objective: In this course, the architectural, software, and algorithmic issues are covered by (a) background discussions of formal theory of parallel and vector algorithms with applications, and (b) presentations on four current vector processors and their application to large scientific and engineering problems. The course will consist of lectures and informal laboratory sessions with counseling. Three major vector processors - the Burroughs BSP, the Control Data CYBER 203, and the Cray Research CRAY-1 - are all available for benchmarking for the first time. Arrangements have been made to have both remote, high-speed access and site counselors from the processor manufacturers. The serious student should have adequate access to all of the processors to achieve at least local vectorization of small FORTRAN programs and to invoke special vector constructs and available mathematical software (equation and recurrence solvers, FFT's, etc.).

Contact: Engineering Summer Conferences, 400 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

MACHINERY VIBRATION ANALYSIS

Dates: August 26-28, 1980
Place: Las Vegas, Nevada
Dates: December 10-12, 1980
Place: New Orleans, Louisiana
Objective: The course covers causes, effects, detection, and solutions of problems relating to rotating machines. Vibration sources, such as oil and resonant whirl, beats, assembly errors, rotor flexibility, whip, damping, eccentricity, etc. will be discussed. The effect on the overall vibration level due to the interaction of a machine's structure, foundation, and components will be illustrated.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

SEPTEMBER

UNDERWATER ACOUSTICS

Dates: September 8-12, 1980
Place: University Park, Pennsylvania
Objective: This is a concentrated course designed to cover the basic principles of underwater acoustics as well as current research and recent developments in the field. The course is intended to serve as an introductory course for those who are new to the field but have the appropriate educational background; and as a refresher course for scientists, engineers, program managers, and administrators engaged in underwater acoustics. Topics will include: basic acoustics; sonar concepts; ambient noise; reverberation; underwater acoustics transmission; transducer concepts; nonlinear acoustics/parametric arrays; target physics; and flow noise.

Contact: Robert E. Beam, Conference Coordinator, Pennsylvania State University, Faculty Building, University Park, PA 16802 - (814) 865-5141.

9TH ANNUAL INSTITUTE ON THE MODERN VIEW OF FATIGUE AND ITS RELATION TO ENGINEERING PROBLEMS

Dates: September 8-12, 1980
Place: Schenectady, New York
Objective: This course will emphasize the relationships of our current physical and phenomenological understanding of fatigue to the engineering treatment of the problem. The curriculum will be built around the several stages of the fatigue process including consideration of the plastic zone, crack nucleation and early growth, crack propagation in the plastic regime, crack propagation in the elastic regime, and failure. Examples from service failures will be introduced when appropriate.

Contact: Graduate Studies and Continuing Education, Union College, Wells House, 1 Union Ave., Schenectady, New York 12308 - (518) 370-6288.

DIGITAL SIGNAL PROCESSING

Dates: September 9-12, 1980
Place: Dallas, Texas
Dates: September 16-19, 1980
Place: Chicago, Illinois
Dates: September 23-26, 1980
Place: Salt Lake City, Utah
Dates: September 30 - October 3, 1980
Place: Boston, Massachusetts
Objective: A course designed to provide the attendee with a comprehensive yet basic knowledge of theory, design, implementation and applications of digital signal processing techniques. Heavy emphasis is placed on the practical applications of time series analysis: curve fitting, vibration control, modal testing, shock spectra, wave form control, real time control, etc. Instructional laboratories and equipment demonstrations by manufacturer.

Contact: Onstead and Associates, Inc., 1333 Lawrence Expressway, Bldg. 100, Suite 103, Santa Clara, CA 95051 - (408) 246-7656.

MODAL VIBRATION TESTING IBRAHIM TECHNIQUE

Dates: September 11-12, 1980
Place: Atlanta, Georgia
Dates: October 9-10, 1980
Place: Boston, Massachusetts
Objective: Theory and use of the ITD method. Determining modal vibration parameters through a computational procedure utilizing a structure's free decay response or random response data, without the need for measuring the input forces. Free software.

Contact: Onstead and Associates, Inc., 1333 Lawrence Expressway, Bldg. 100, Suite 103, Santa Clara, CA 95051 - (408) 246-7656.

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: September 15-19, 1980
Place: Ottawa, Canada
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

9TH ADVANCED NOISE AND VIBRATION COURSE

Dates: September 15-19, 1980
Place: Institute of Sound and Vibration Research, University of Southampton, UK
Objective: The course is aimed at researchers and development engineers in industry and research establishments, and people in other spheres who are associated with noise and vibration problems. The course, which is designed to refresh and cover the latest theories and techniques, initially deals with fundamentals and common ground and then offers a choice of specialist topics. The course comprises over thirty lectures, including the basic subjects of acoustics, random processes, vibration theory, subjective response and aerodynamic noise, which form the central core of the course. In addition, several

specialist applied topics are offered, including aircraft noise, road traffic noise, industrial machinery noise, diesel engine noise, process plant noise, and environmental noise and planning.

Contact: Mrs. O.G. Hyde, ISVR Conference Secretary, The University of Southampton, S09 5NH UK-Southampton (0703) 559122, Ext. 2310 or 752, Telex: 47661

MODAL ANALYSIS
Dates: September 17-19, 1980
Place: Cleveland, Ohio
Objective: This seminar will provide information on new techniques for identifying dynamic structural weaknesses. The sessions include the use of state-of-the-art instrumentation and software for creating a dynamic structural model in the computer. Techniques will be demonstrated for mode shape calculation and animated displays, computation of mass, stiffness and damping values and modal manipulation methods.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

SHOCK AND VIBRATION MEASUREMENT TECHNOLOGY
Dates: September 23-25, 1980
Place: Laguna Hills, California
Objective: This application-oriented seminar is structured to give engineers and senior technicians a review of the basics and an opportunity to broaden their working knowledge in all aspects of accelerometer selection, installation, cabling, conditioning and calibration. A forum on pyrotechnic testing and pyrotechnic simulation will also be given.

Contact: Tony Schneider, Endevco, Rancho Viejo Road, San Juan Capistrano, CA 92675 - (714) 493-8181.

BLASTING AND EXPLOSIVES SAFETY TRAINING
Dates: September 24-26, 1980
Place: Des Moines, Iowa
Dates: October 8-10, 1980
Place: Nashville, Tennessee
Dates: October 22-24, 1980
Place: Casper, Wyoming
Dates: November 5-7, 1980
Place: Hershey, Pennsylvania
Dates: November 19-21, 1980
Place: Lexington, Kentucky
Dates: December 3-5, 1980
Place: Kansas City, Missouri
Objective: This course is a basic course that teaches safe methods for handling and using commercial explosives. We approach the problems by getting at the reasons for safety rules and regulations. Helps provide blasters and supervisors with a practical understanding of explosives and their use - stressing importance of safety leadership. Familiarizes risk management and safety personnel with safety considerations of explosives products and blasting methods.

Contact: E.I. du Pont de Nemours & Co. (Inc.), Applied Technology Division, Wilmington, DE 19898 - (302) 772-5982/774-6406.

VIBRATION CONTROL
Dates: September 29 - October 3, 1980
Place: Pennsylvania State University
Objective: This seminar will be of interest and value to engineers and scientists in industry, government, and education. Topics for consideration include dynamic mechanical properties of viscoelastic materials; structural and constrained-layer damping; isolation of machinery vibration from rigid and nonrigid substructures; isolation of impact transients; reduction of vibration in beams, plates, shells, periodic structures, stiffened plates, and rings and ring segments; and characteristics of multi-resonant vibrators. Each student will receive bound lecture notes and copies of six textbooks for his permanent reference.

Contact: Professor John C. Snowdon, Seminar Chairman, Applied Research Laboratory, Pennsylvania State University, P.O. Box 30, State College, PA 16801.

OCTOBER

VIBRATION DAMPING
Dates: October 6-9, 1980
Place: Dayton, Ohio

Objective: This course is designed to teach vibration damping fundamentals, analytical methods and experimental techniques required to design and apply damping treatments which will solve vibration problems. The course is comprised of lectures, workshops, and laboratory demonstrations of methods used to measure damping material properties, to apply damping materials to structures, and to test damped and undamped structures. Computerized approaches for incorporating damping into new and existing structures and techniques for using viscoelastic materials for reducing noise will be discussed. The practical approach to problem solutions will be emphasized. The design techniques presented will be applicable to the design of viscoelasticity damped structures and will include use of newly established approaches which make use of both specialized and routine finite element analysis. The course content of this course is up-dated annually to reflect the latest developments of vibration damping technology.

Contact: Mr. Dale H. Whitford, Research Institute - KL 501, University of Dayton, Dayton, OH 45469 - (513) 229-4235.

VIBRATION TESTING

Dates: October 6-9, 1980
Place: San Diego, California
Objective Topics to be covered are: exciters, fixtures, transducers, test specifications and the latest computerized techniques for equalization, control, and protection. Subjects covered include dynamics and dynamic measurements of mechanical systems, vibration and shock specifications and data generation. Demonstrations are given of sine random and shock testing and of how test specifications are met.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

SENSORS, INSTRUMENTATION AND MEASUREMENTS

Dates: October 7-10, 1980
Place: Dallas, Texas
Dates: October 14-17, 1980
Place: Chicago, Illinois
Dates: October 21-24, 1980
Place: Salt Lake City, Utah
Dates: October 28-31, 1980
Place: Boston, Massachusetts
Objective: A course for individuals involved in the selection and calibration of sensors and measurement instrumentation, the taking of dynamic measurements, performing modal or signature analysis, etc. Course includes laboratories on sensors and signal conditioning, data archiving, IEEE Bus, calculators, computers and analyzers. Instructional laboratories and equipment demonstrations by manufacturer.

Contact: Onstead and Associates, Inc., 1333 Lawrence Expressway, Bldg. 100, Suite 103, Santa Clara, CA 95051 - (408) 246-7656.

SCALE MODELING IN ENGINEERING DYNAMICS

Dates: October 20-24, 1980
Place: San Antonio, Texas
Objective: The course will begin with a drop test demonstration of damage to model and prototype cantilever beams made from different materials. These tests help to introduce the concepts of similarity and of physical dimensions which are preliminary to any model analysis. Formal mathematical techniques of modeling will then be presented including the development of scaling laws from both differential equations and the Buckingham Pi Theorem. A number of sessions then follow wherein the instructors present specific analyses relating to a variety of dynamic vibrations and transient response problems. The problems are selected to illustrate the use of models as an analysis tool and to give examples of variations on different modeling techniques. Types of problems presented include impact, blast, fragmentation, and thermal pulses on ground, air and floating structures.

Contact: Wilfred E. Baker, Southwest Research Institute, 6220 Culebra Road, P.O. Box 28510, San Antonio, Texas 78284 - (512) 684-5111, Ext. 2303.

DIGITAL SIGNAL PROCESSING

Dates: October 21-23, 1980
Place: Atlanta, Georgia
Objective: The mathematical basis for the fast Fourier transform calculation is presented, including frequency response, impulse response, transfer functions, mode shapes and optimized signal detection. Convolution, correlation functions and probability characteristics are described mathematically and each

is demonstrated on the Digital Signal Processor. Other demonstrations include spectrum and power spectrum measurements; relative phase measurements between two signals; and signal source location.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

NOVEMBER

FINITE ELEMENTS: BASIC PRINCIPLES AND PRACTICAL ASPECTS

Dates: November 10-14, 1980
Place: Tucson, Arizona
Objective: The purpose of this course is to provide structural engineering practitioners with an understanding of the fundamental principles of finite element analysis, to describe applications of the method, and to present guidelines for the proper use of the method and interpretation of the results obtained through it. Emphasis will be placed upon the linear analysis of frameworks, plates, shells and solids; dynamic analysis will also be treated. Daily workshop sessions will utilize the GIFTS interactive graphics finite element system, which is a popular stand along analysis capability and which also serves as a pre- and post-processor for such widely used programs as SAP and NASTRAN.

Contact: Dr. Hussein Kamel, College of Engineering, The University of Arizona, Tucson, AZ 85721 - (602) 626-1650/626-3054.

18TH ANNUAL RELIABILITY ENGINEERING AND MANAGEMENT INSTITUTE

Dates: November 10-14, 1980
Place: Tucson, Arizona
Objective: This course will cover the following subjects: reliability engineering theory and practice; mechanical reliability; risk analysis; reliability testing and demonstration; maintainability engineering; product liability; and reliability and maintainability management.

Contact: Dr. Dimitri Kececioglu, Aeronautical Engineering Bldg. 16, University of Arizona, Tucson, AZ 85721 - (602) 626-2495/626-3901/626-3054.

MACHINERY VIBRATION IV

Dates: November 11-13, 1980
Place: Cherry Hill, New Jersey
Objective: Lectures and demonstrations on vibration measurement rotor dynamics and torsional vibration are scheduled. General sessions will serve as a review of the technology; included are the topics of machine measurements, modal vibration analysis, and vibration and noise. The rotor dynamics sessions will include: using finite element, transfer matrix, and nonlinear models; vibration control including isolation, damping, and balancing. The sessions on torsional vibration feature fundamentals, modeling measurement and data analysis, self-excited vibrations, isolation and damping, transient analysis, and design of machine systems.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

MODAL ANALYSIS, SUBSTRUCTURING AND TESTING

Dates: November 11-14, 1980
Place: Chicago, Illinois
Dates: November 18-21, 1980
Place: Dallas, Texas
Dates: December 2-5, 1980
Place: Salt Lake City, Utah
Dates: December 9-12, 1980
Place: Boston, Massachusetts
Objective: A state-of-the-art presentation on structural analysis techniques combined with laboratory demonstrations. Covers mechanical structures, modes of vibration, modal analysis, structural testing, finite element modeling and substructuring including structural dynamics modification techniques. Instructional laboratories and equipment demonstrations by manufacturer.

Contact: Onstead and Associates, Inc., 1333 Lawrence Expressway, Bldg. 100, Suite 103, Santa Clara, CA 95051 - (408) 246-7656.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

TWELFTH ANNUAL PITTSBURGH CONFERENCE ON MODELING AND SIMULATION
April 30 - May 1, 1981
Call for Papers

Special emphasis for the 1981 Conference will be microprocessors and their applications as well as energy, social, economic, and global modeling and simulation and papers on all traditional areas of modeling and simulation.

Only papers which have not been published previously will be considered. These papers should describe significant contributions which add to the knowledge in a particular area or which describe the origin and progress of research that is being currently conducted. All papers submitted and accepted for presentation at the Conference will be considered for publication in the PROCEEDINGS. There will be a length limitation on all papers but additional space in the PROCEEDINGS may be purchased at a nominal cost.

Two copies of titles, authors, all author's addresses, abstracts and summaries should be submitted by January 31, 1981. The abstract should be approximately 50 words in length and the summary should be of sufficient length and detail to permit careful evaluation. Identify one author as the correspondent for the paper. All communications will be with this author. Notification of acceptance for presentation will be given by March 6, 1981. Instructions and model paper for the preparation of accepted papers will be mailed to each author. The final typed manuscript will be due May 1, 1981.

For further information, contact: William G. Vogt or Marlin H. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, Pennsylvania 15261.

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 1814, 1938)

80-1748

Experimental Evaluation of the Predicted Behaviour of Squeeze-Film-Bearing-Supported Rigid Rotors

S. Simandiri and E.J. Hahn
Advance Research Lab., Rolls Royce Ltd., Derby, J. Mech. Engrg. Sci., 21 (6), pp 439-451 (Dec 1979) 13 figs, 2 tables, 24 refs

Key Words: Rotor-bearing systems, Bearings, Squeeze-film bearings

Experimental investigations which were conducted to verify existing theoretical vibration-amplitude predictions for centrally-preloaded, squeeze-film-bearing-supported rigid rotors are described. Very good agreement was obtained with all aspects of these predictions, including the degree of pressurization needed to achieve full-film lubrication and the complicated bistable operation behavior. By developing the theoretical model for the more general case of a rigid rotor supported by unequal squeeze-film bearings at the ends, it is shown how existing theoretical data, derived on the basis of a symmetric rotor with symmetric motion, are readily applicable to the case of a rotor supported by squeeze-film bearings at one end only.

80-1749

Adjustment of Rotor Model to Achieve Agreement Between Calculated and Experimental Natural Frequencies

G.T.S. Done
Dept. of Mech. Engrg., The City Univ., J. Mech. Engrg. Sci., 21 (6), pp 389-396 (Dec 1979) 6 figs, 1 table, 11 refs

Key Words: Rotors (machine elements), Natural frequencies, Experimental data, Timoshenko theories

The adjustment of mathematical models so that the computed natural frequencies coincide with those measured experimentally is presented. The particular system considered is a laboratory turbine-rotor model, modeled mathematically by 42 Timoshenko beam elements and lumped masses. Model adjustments are made by assuming, first, Young's modulus and the modulus of rigidity are variable, a change from standard values representing overall stiffness deficiencies in the mathematical model. In this case, a best fit to the lowest six natural frequencies, as measured experimentally, is made. Secondly, stiffness diameters are assumed variable, thereby allowing for deficiencies in the model near discontinuous changes of section, and in this case, the lowest six natural frequencies are matched exactly, but an overall measure of the differences between the actual and the stiffness diameters is minimized. An analysis for the rates of change of natural frequency with the various stiffness properties (i.e. the sensitivities) is presented, and the results of the manipulation discussed.

80-1750

Direct Integration of Transient Rotor Dynamics

A.F. Kascak
Lewis Research Center, NASA, Cleveland, OH, Rept. No. NASA-TP-1597, 23 pp (Jan 1980)
N80-15128

Key Words: Rotors (machine elements), Lumped parameter method, Computer programs, Rotor-bearing systems

An implicit method was developed for integrating the equations of motion for a lumped mass model of a rotor dynamics system. A closed form solution to the short bearing theory was also developed for a damper with arbitrary motion. The major conclusions are that the method is numerically stable and that the computation time is proportional to the number of elements in the rotor dynamics model rather than to the cube of the number.

80-1751

Dynamics of Flexible Rotors Partially Filled with a Viscous Incompressible Fluid

S.L. Hendricks
Ph.D. Thesis, Univ. of Virginia, 125 pp (1979)
UM 8004603

Key Words: Rotors (machine elements), Flexible rotors, Cylindrical shells, Fluid-filled containers, Fluid-induced excitation

A linear theory is developed to study the motion of a hollow circular cylinder rotating with constant angular velocity and partially filled with a viscous incompressible fluid. Many different rotor models can be studied using this analysis. A two-

dimensional theory which ignores axial motion in the fluid is discussed first. This theory exhibits all of the essential features of liquid-rotor coupling and is used to analyze a simple rotor configuration and explore the ramifications of the analysis. The full three-dimensional theory is then developed and used to analyze more complicated rotors. The results of this analysis predict that over a range of operating speeds, the rotor-fluid system is unstable. The extent of this unstable region is determined by the system parameters. The interplay between the viscosity of the fluid and damping on the rotor is especially important in determining stability boundaries.

80-1752

The Effect of Load and Feed Pressure on Whirl in a Grooved Journal Bearing

M. Akkok and C.M.M. Ettles

Imperial College, London SW7, 2BX, UK, ASLE Trans., 23 (2), pp 175-184 (Apr 1980) 8 figs, 8 refs

Key Words: Rotor-bearing systems, Bearings, Journal bearings, Whirling, Shafts

An experimental investigation is described of the whirl stability of a circumferentially grooved journal bearing carrying a stiff rotor. The shaft and bearing were made with a slight taper so that the clearance could be infinitely varied, and the assembly could be tilted to any angle between the horizontal and vertical directions to vary the load on the bearing. These features allowed a wide range of running conditions. Experimental results imply that subambient film pressures are negligible, regardless of load, and that Reynolds boundary conditions apply with cavitation at ambient pressure. This has an important effect on film extent and, consequently, on promoting stability. The influence of feed pressure on the control of film extent, and hence on stability, is shown by analysis and experiment.

80-1753

Damping of Subsynchronous Resonance in Series-Compensated Systems by Excitation Control

F.M. Hughes and H.M.A. Hamdan

Dept. of Control Engrg., Univ. of Manchester Inst. of Sci. and Tech., Manchester M60 1QD, England, Intl. J. Control, 31 (1), pp 63-77 (Jan 1980) 10 figs, 11 refs

Key Words: Vibration damping, Electric power plants, Shafts

Fast-response excitation systems are capable of influencing turbogenerator performance at subsynchronous resonance frequencies, and this paper shows how suitable excitation control can improve the damping of a generator subsynchronous shaft oscillations. A multivariable frequency response method is used to investigate control capabilities and to identify the most beneficial control signals and stabilization requirements. An excitation control scheme is designed, employing a differential shaft speed signal, which stabilizes an initially unstable resonance condition and provides rapid damping of subsynchronous shaft oscillations.

80-1754

Aerodynamic and Acoustic Investigations of Axial Flow Fan and Compressor Blade Rows, Including Three-Dimensional Effects

G.F. Homicz, J.A. Lordi, and G.R. Ludwig

Aerodynamic Res. Dept., Calspan Advanced Tech. Ctr., Buffalo, NY, Rept. No. CALSPAN-EX-5933-A-103, AFAPL-TR-79-2061, 147 pp (Aug 1979) AD-A077 712/8

Key Words: Compressor blades, Blades, Fans, Aerodynamic characteristics

The influence of three-dimensional effects on the aerodynamics and acoustics of axial flow fans and compressors is investigated, using linearized analysis.

80-1755

Acoustically Swept Rotor

F.H. Schmitz, D.A. Boxwell, and R. Vause

Ames Research Ctr., NASA, Moffett Field, CA, US-Patent-4,168,939, 23 pp (Sept 25, 1979)

Key Words: Rotors (machine elements), Noise reduction

Impulsive noise reduction is provided in a rotor blade by acoustically sweeping the chord line from root to tip so that the acoustic radiation resulting from the summation of potential singularities used to model the flow about the blade tend to cancel for all times at an observation point in the acoustic far field.

80-1756

The Status of Rotor Noise Technology

R.P. White, Jr.

RASA Div., Systems Research Labs., Inc., J. Amer. Helicopter Soc., 25 (1), pp 22-29 (Jan 1980) 11 figs, 55 refs

Key Words: Helicopter rotors, Rotor (machine elements), Noise reduction, Noise generation

The state of helicopter rotor noise technology is reviewed by identifying the various characteristics of rotor noise. Then the prediction of the most important rotor noise characteristics in a real-world environment is reviewed.

80-1757
Noise Reduction
C.E. Feiler, J.F. Groeneweg, F.J. Montegani, J.P. Raney, E.J. Rice, and J.R. Stone
NASA, Lewis Res. Ctr., Cleveland, OH, Aeropropulsion 1979, pp 85-128 (1979)
N80-10208

Key Words: Turbofan engines, Noise reduction

The turbofan engine's noise-producing components are discussed in terms of efficient and economical noise reduction techniques that do not penalize the engine performance or weight significantly. Specific topics covered include fan noise, acoustic suppression, jet noise technology, combustor noise, and aircraft noise prediction.

80-1758
The Correct Selection and Installation of Compressors
J.A. Kane
APE-Bellis Ltd., Noise Vib. Control, 11 (2), pp 50-53 (Feb 1980) 3 figs

Key Words: Compressors, Vibration control, Noise reduction

The characteristics of various ancillary equipment, such as filtration systems, pulsation dampers and silencers, required for an optimum operation of compressors is discussed.

RECIPROCATING MACHINES
(See No. 1758)

POWER TRANSMISSION SYSTEMS
(Also see No. 1941)

80-1759
Development of a Four-Speed Automatic Transmission with Overdrive
A. Numazawa, S. Kubo, Y. Shindo, and S. Moroto
Toyota Motor Co., Ltd., Aisin Warner Ltd., Anjo, Japan, Intl. J. Vehicle Des., 1 (2), pp 151-164 (Feb 1980) 11 figs, 4 tables, 2 refs

Key Words: Power transmission systems, Design techniques, Noise reduction

A new four-speed automatic transmission with overdrive has been developed and put into production for the purpose of improvement of fuel economy and the reduction of engine noise. This paper describes the design features and the confirmation testings of the transmission, and also refers to effects on fuel economy and noise reduction of the transmission in the vehicle.

METAL WORKING AND FORMING
(Also see No. 1897)

80-1760
Stability of Machine Tools at Cutter Head Milling (Stabilitätsverhalten von Werkzeugnaschinen beim Fräskopffräsen)
B. Hentschel, S. Recklies, and H.-J. Jacobs
Technische Universität Dresden, Germany, Maschinenbautechnik, 28 (12), pp 565-568 (Dec 1979) 3 figs
(In German)

Key Words: Machine tools, Stability

A mathematical model for the oscillation of cutter heads is presented to be used in the design of machine tools and the optimization of machining processes.

STRUCTURAL SYSTEMS

BRIDGES

80-1761
Dynamic Loading of Highway Bridges
R.K. Gupta

Papua New Guinea Univ. of Tech., Lae, Papua New Guinea, ASCE J. Engr. Mech. Div., 106 (2), pp 377-394 (Apr 1980) 15 figs, 19 refs

Key Words: Bridges, Beams, Plates, Moving loads

Single span highway bridges of composite construction are idealized as beams as well as an orthotropic plate. A standard HS-20-44 highway vehicle is represented by a planar, two axle, sprung mass system with a frictional device. The response equations are derived in terms of the natural modal coordinates of the bridge and of displacement coordinates of the vehicle. The bridge dynamic loadings due to the initial bounce of the vehicle and in combination with the braking of the vehicle are investigated for symmetric as well as eccentric loading of the vehicle.

80-1762

Bridge Dynamic Loading Due to Road Surface Irregularities and Braking of Vehicle

R.K. Gupta and R.W. Traill-Nash

School of Civil Engr., The Univ. of New South Wales, Australia, Intl. J. Earthquake Engr. Struc. Dynam., 8 (2), pp 83-96 (Mar/Apr 1980) 10 figs, 20 refs

Key Words: Bridges, Composite structures, Moving loads, Beams, Plates

Single span highway bridges of composite construction are idealized as beams as well as orthotropic plates. A representative highway vehicle is presented by a planar, two-axle, sprung mass system with frictional device. The maximum impact factors for bending moment and deflection are obtained due to the ramp and in combination with the braking of vehicle for symmetric as well as essentric loading of the vehicle.

80-1763

Quinnipiac River Bridge Cracking

J.W. Fisher, A.W. Pense, H. Hausammann, and G.R. Irwin

Fritz Engrg. Lab., Lehigh Univ., Bethlehem, PA, ASCE J. Struc Div., 106 (4), pp 773-789 (Apr 1980) 16 figs, 14 refs

Key Words: Bridges, Fatigue life, Crack propagation

Crack propagation in a fascia girder of the suspended span of the Quinnipiac River Bridge near New Haven, Connecticut was investigated. The mechanism of the crack growth is explained.

80-1764

Aeroelastic Stability of Suspension Bridges

A. Petre and R. Sofronie

Dept. of Aeronautical Engrg., Bucharest, Rev. Roumaine Sci. Tech., Mécanique, 24 (5), pp 819-832 (Sept/Oct 1979) 1 fig, 15 refs

Key Words: Bridges, Suspension bridges, Aeroelasticity

An advanced theory on the aeroelastic stability of suspension bridges has been developed by taking into account the drag effect of the aerodynamically shaped decks. The theory includes both structural systems of suspension bridges, the classical system of hanging bridges and the new system of prestressed bridges. Practical methods to solve in a more reliable manner the stability problems of suspension bridges have also been suggested.

BUILDINGS

(Also see Nos. 1847, 1913, 1968)

80-1765

Collapse of a Model for Ductile Reinforced Concrete Frames under Extreme Earthquake Motions

H. Takizawa and P.C. Jennings

Faculty of Engr., Hokkaido Univ., Sapporo, Hokkaido, Japan, Intl. J. Earthquake Engr. Struc., 8 (2), pp 117-144 (Mar/Apr 1980) 12 figs, 3 tables, 28 refs

Key Words: Frames, Buildings, Concretes, Reinforced concrete, Seismic response

A mathematical formulation is presented for modeling the dynamic process of failure of a class of ductile, moment-resisting, reinforced concrete (R/C) frame buildings when subjected to intense earthquake motion. The formulation includes the geometrically non-linear term that accounts for the destabilizing action of gravity. Special examination is made of the capacity to resist short-duration motions consisting of a few pulses versus the capacity to resist motions of longer duration. For the class of structures modeled, the results indicate an extremely low destructive capability associated with short-duration motions, even when they have very high accelerations. The application in research of a two-parameter characterization of the severity of ground motion in terms of intensity and duration is also examined.

80-1766

Structural Identification in the Frequency Domain from Earthquake Records

G.H. McVerry

Applied Mechanics Dept., California Inst. of Tech., Pasadena, CA, Intl. J. Earthquake Engr. Struc. Dynam., 8 (2), pp 161-180 (Mar/Apr 1980) 9 figs, 5 tables, 13 refs

Key Words: Parameter identification technique, Seismic response, Frequency domain method

A method has been developed to identify the parameters of the lower modes of a linear, time-invariant model of a structure from its recorded earthquake response. The identification is performed by selecting the parameters to obtain a least squares fit over a specified frequency band between the unsmoothed, complex-valued finite Fourier transform of the recorded acceleration response and the corresponding transform calculated from the response of the model. By including the effects of the initial and final conditions in the analysis, only a portion of the recorded excitation and response acceleration histories need be considered. The method is demonstrated first by an application to generated test data, and then to measured earthquake response.

80-1767

Frequency Domain Identification of Structural Models from Earthquake Records

G.H. McVerry

Ph.D. Thesis, California Inst. of Tech., 220 pp (1980)
UM 8006720

Key Words: Buildings, Seismic response, System identification technique

The usefulness of simple linear mathematical models for representing the behavior of tall buildings during earthquake response is investigated for a variety of structures over a range of motions including the onset of structural damage.

80-1768

Seismic Design of Reinforced Concrete Buildings: An Inelastic Response Spectrum Approach

P.D. Bernal

Ph.D. Thesis, Univ. of Tennessee, 212 pp (1979)
UM 8005367

Key Words: Buildings, Reinforced concrete, Seismic response, Seismic design

The applicability of the Inelastic Response Spectrum Approach (IRSA) as a tool for the design of moment-resisting, reinforced concrete frames under seismic excitation was tested by comparing the predicted results to those obtained from a rigorous, step-by-step, inelastic dynamic analysis. Two frames were designed for various combinations of ground motions and design ductilities and then analyzed using DRAIN-2D, a computer program with inelastic dynamic analysis capabilities.

TOWERS

80-1769

Elastic-Plastic Seismic Response of Chimney

L. Shiau and H.T.Y. Yang

Sargent and Lundy Engineers, Chicago, IL, ASCE J. Struc. Div., 106 (4), pp 791-807 (Apr 1980) 11 figs, 2 tables, 15 refs

Key Words: Towers, Chimneys, Seismic response, Elastic-plastic properties, Crack propagation, Finite element technique

An analytic investigation of the elastic and inelastic response behavior of a chimney to a realistic earthquake record is conducted.

FOUNDATIONS

(Also see No. 1773)

80-1770

Seismic Excitation of a Structure by Surface Waves

U. Gamer

Institut f. Mechanik, Technische Universität Wien, Karlsplatz 13, A-1040 WIEN, Rev. Roumaine Sci. Tech., Méc. Appl., 24 (4), pp 613-621 (July/Aug 1979) 3 figs, 7 refs

Key Words: Foundations, Seismic excitation

The forced horizontal, vertical, and rocking vibrations of a rigid foundation connected with the soil through a continuous damper caused by a periodic Rayleigh wave are studied.

UNDERGROUND STRUCTURES

(See No. 1873)

HARBORS AND DAMS

80-1771

Earthquake Analysis of the Gravity Dam Monoliths of the Richard B. Russell Dam

C.D. Norman and H.E. Stone

Structures Lab., Army Engineer Waterways Experiment Station, Vicksburg, MS, Rept. No. WES/SL-79-8, 140 pp (Sept 1979)

AD-A077 658/3

Key Words: Dams, Concretes, Earthquake response, Computer programs, Finite element technique

Finite element computer analyses were performed for critical concrete sections of a dam using as input several acceleration-time histories recommended by a panel of geologists and seismologists.

ROADS AND TRACKS

80-1772

Response of a Roadway Lying on an Elastic Foundation to Random Traffic Loads

D. Le Houedec

Civil Engrg. Lab., E.N.S.M., Univ. of Nantes, 1, rue de la Noë, 44072 Nantes Cedex, France, J. Appl. Mech., Trans. ASME, 47 (1), pp 145-149 (Mar 1980) 5 figs, 10 refs

Key Words: Roads (pavements), Elastic foundations, Moving loads, Traffic-induced vibrations

This paper analyzes the response of a roadway lying on a Westergaard foundation to the pressures of a load moving on a random profile at a constant velocity. The profile power spectrum is based on experimental recordings done on French roads.

CONSTRUCTION EQUIPMENT

80-1773

Dynamic Behaviour of an Ore-Mill Foundation and Its Vibration Prevention

P.A.A. Laura, J.L. Pombo, and S. LaMalfa

Inst. of Applied Mechanics, Base Naval Puerto Belgrano 8111 Argentina, Appl. Acoust., 13 (1), pp 1-6 (Jan/Feb 1980) 7 figs, 2 refs

Key Words: Mining equipment, Vibration control, Experimental data, Machine foundations

The excessive vibration of an ore-mill during operation is investigated experimentally. An appropriate experimental model was developed and its vibration level was reduced by adding damping and/or stiffness to the foundation. The feasibility of implementing the laboratory solution is discussed.

80-1774

Seismic Excitation of Cranes (Seismische Beanspruchungen der Krane)

M. Kos

Maschinenbau-Fakultät Ljubljana, Yugoslavia, Konstruktion, 32 (3), pp 105-109 (Mar 1980) 6 figs

(In German)

Key Words: Cranes (hoists), Seismic excitation

Seismic effects in the horizontal and vertical directions on various types of cranes are investigated by means of a mathematical model. From the seismic results obtained the design of the cranes may be optimized. The destabilizing forces, which threaten to displace the crane and its components, can be determined.

80-1775

The Dynamic Behaviour of Offshore Platform Cranes

D.G. Owen

Dept. of Offshore Engrg., Heriot-Watt Univ., Edinburgh, The Structural Engineer, 57B (4), pp 85-90 (Dec 1979) 8 figs, 13 refs

Key Words: Cranes (hoists), Off-shore structures

A simplified dynamic model of a marine crane is used to calculate the magnitude of dynamic loads arising from lifting cargoes from the deck of a moving supply boat.

PRESSURE VESSELS

80-1776

Review of Analytical and Experimental Techniques for Improving Structural Dynamic Models

P. Ibanez
Anco Engineers, Inc., Santa Monica, CA 90404, Welding Research Council Bulletin No. 249, 46 pp (June 1979)

Key Words: Pressure vessels, Vibration measurement, Measurement techniques, Measuring instruments, System identification techniques, Parameter identification technique, Computer-aided techniques

The various experimental techniques used to excite pressure vessel systems include measuring response to ambient and operational vibrations, occasional high-level seismic input, and artificially applied forces such as impulsive, sinusoidal, shock, and random excitation. The discussion covers instrumentation used to excite and measure response, as well as data acquisition and reduction systems and computer programs. Preliminary data processing -- including calibration, conversion to engineering units, correlation, baseline connection, filtering, spectral analysis, and graphical presentation – is also analyzed.

POWER PLANTS

(See No. 1930)

OFF-SHORE STRUCTURES

80-1777

The Effect of Liquid Storage Tanks on the Dynamic Response of Offshore Platforms

J.K. Vandiver and S. Mitome
Massachusetts Inst. of Tech., J. Petroleum Tech., 31 (10), pp 1231-1240 (Oct 1979) 12 figs, 11 refs

Key Words: Storage tanks, Off-shore structures, Sloshing, Fluid-induced excitations, Natural frequencies, Vibration damping

The sloshing of liquids in storage tanks on fixed offshore structures affects the structures' natural frequencies and damping. Analytic procedures by which one may account for these effects are presented. A method for designing tankage that suppresses the dynamic response at the fundamental flexural natural frequency of the structure is proposed. Supporting data from full-scale field studies are presented.

80-1778

On the Reliability of Standard Wave Spectra in Structural Response Analysis

N. Spidsöe and R. Sigbjörnsson
Div. of Marine Struc., Norwegian Inst. of Tech., Trondheim, Norway, Engrg. Struc., 2 (2), pp 123-135 (Apr 1980) 9 figs, 4 tables, 16 refs

Key Words: Off-shore structures, Spectral energy distribution techniques, Water waves

The present study is intended to elucidate the reliability of the most common standard models of one-dimensional wave spectral densities applied in the design of fixed offshore structures. The results presented refer especially to flexible offshore platforms of the gravity type. The study is based on a comparative analysis of typical structural response quantities derived, by applying wave spectra obtained from wave measurements and standard wave spectra. The analysis includes 1008 empirical wave spectra estimated from wave measurements at three different locations on the Norwegian Continental Shelf.

80-1779

Fatigue Analysis of Offshore Structures

J.R. Wallis, Y.O. Bayazitoglu, F.M. Chapman, Jr. and A. Mangiavacchi
Brown and Root, Inc., J. Petroleum Tech., 31 (12), pp 1614-1622 (Dec 1979) 5 figs, 1 table, 11 refs (See also 80-738)

Key Words: Off-shore structures, Fatigue life, Water waves, Spectrum analysis

This paper presents a procedure for fatigue analysis where the dynamic response of the structure is analyzed through a spectral approach. The sea waves, which constitute the forcing function acting on the structure, are represented as energy spectra; the response is obtained in spectral terms and subsequently is interpreted according to probabilistic concepts.

80-1780

Fatigue Reliability in Welded Joints of Offshore Structures

P.H. Wirsching
Dept. of Aerospace and Mech. Engrg., College of Engrg., University of Arizona, Tucson, AZ 85721, Intl. J. Fatigue, 2 (2), pp 77-83 (Apr 1980) 6 figs, 4 tables, 28 refs

Key Words: Off-shore structures, Fatigue (materials), Fatigue life

Metal fatigue in welded joints in offshore structures is considered. Due to the considerable variability of conditions, a probabilistic approach is used. Theoretical studies of various aspects of the fatigue reliability problem in welded joints are presented. These include a study of the Palmgren-Miner rule, a modified linear model on S/N data, the use of the rainflow method of counting, and a closed form expression for the probability of fatigue failure. A probability model is derived as a suggested basis for an approach to fatigue design.

80-1781

Motion, Fatigue, and the Reliability Characteristics of a Vertically Moored Platform

P.A. Beynet, M.Y. Berman, and J.T. Von Ashwege

Amoco Production Co., J. Petroleum Tech., 31 (3), pp 267-274 (Mar 1979) 10 figs, 9 refs

Key Words: Off-shore structures, Water waves, Wind-induced excitation, Fatigue life

The vertically moored platform is a buoyant structure for deepwater drilling and production that uses tensioned vertical mooring risers integral with platform wells. The dynamic response of the structure to wind, wave, and current is analyzed. A model for relating environmental conditions to riser stresses is outlined.

80-1782

Fatigue Analysis of the Cognac Platform

R.K. Kinra and P.W. Marshall

Shell Oil Co., J. Petroleum Tech., 32 (3), pp 374-386 (Mar 1980) 13 figs, 6 tables, 16 refs

Key Words: Off-shore structures, Fatigue life, Statistical analysis, Spectrum analysis

This paper describes preliminary and detailed fatigue analyses of the 1,000-ft-deep Cognac platform. Dynamic structural analysis is used to generate local member stress transfer function data, and probabilistic spectral techniques are employed to evaluate long-term stress statistics and fatigue lives using Miner's cumulative damage rule. Directional spreading of wave energy is considered in the analysis.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 1846, 1973, 1975)

80-1783

Correlation of Field Injuries and GM Hybrid III Dummy Responses for Lap-Shoulder Belt Restraint

G.W. Nyquist, P.C. Bergman, A.I. King, and H.J. Mertz

General Motors Corp., Warren, MI, ASME Paper No. 79-WA/Bio-2

Key Words: Collision research (automotive), Anthropomorphic dummies, Experimental data, Seat belts, Safety restraint systems

Simulated frontal, lap-shoulder belted, barrier impact tests were performed using a Volvo sedan and General Motors Hybrid III anthropomorphic test dummy. The injuries were subdivided into four body regions: head, neck, thorax, and lower torso. The Hybrid III has instrumentation in each of these regions. The results of three replicated tests of barrier equivalent velocities of nominally 32 and 48 km/h are discussed in terms of the field injuries, thereby providing a basis for more intelligent interpretation of future Hybrid III test results.

80-1784

Determination of the Size of the Storage Chamber and the Charging Pressure for Air Bags Used in Automotive Passive Restraint Systems

M.A. Townsend and D.B. Cherchas

Vanderbilt Univ., Nashville, TN, Intl. J. Vehicle Des., 1 (2), pp 143-150 (Feb 1980) 4 figs, 5 refs

Key Words: Safety restraint systems, Air bags (safety restraint systems), Automobiles

Design and service charts are presented for the prediction of the size and pressure after inflation of an air bag in a passive restraint system for a specified storage chamber size and charging pressure.

80-1785

Railroad Freight Equipment Load Environment Testing

N.J. Darien and A.M. Zarembski

Assn. of American Railroads Technical Ctr., Track Train Dynamics Res. Program, 3140 S. Federal St., Chicago, IL 60616, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1. Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 13-22, 9 figs, 3 tables, 6 refs, Avail: see 80-1972

Key Words: Freight cars, Railroad cars, Fatigue tests, Design techniques

The procedure for acquisition and analysis of the rail service environmental load data for use as the input for freight car fatigue design is described.

80-1786

Stability Bounds of a Tractor-Semitrailer

M. Singh

Stevens Inst. of Tech., Hoboken, NJ, Vehicle Syst. Dyn., 9 (2), pp 69-86 (Mar 1980) 7 figs, 2 tables, 14 refs

Key Words: Articulated vehicles, Stability

The dynamic stability of a tractor-semitrailer is presented here on a qualitative basis. In a four-dimensional space, equilibrium states of the system are discovered which lead to suitable initial conditions for numerical integration of the system equations. The integral solutions define the stable and the unstable regions in the state-space, and thereby reveal the system behavior. A simple example concerning the effect of a front tire blowout illustrates how the theory can expose the vehicle motion under external perturbations.

80-1787

Random Response of Tractor-Semitrailer System

M.A. Dokainish and M.N. Elmandany

Dept. of Mechanical Engrg., McMaster Univ., Hamilton, Ontario, Canada L8S 4L7, Vehicle Syst. Div., 9 (2), pp 87-112 (Mar 1980) 11 figs, 3 tables, 28 refs

Key Words: Articulated vehicles, Digital simulation, Random response, Road roughness

This work describes an analytical study of the dynamic behavior of a tractor-semitrailer vehicle. A digital computer simulation was used to describe the longitudinal, vertical, and pitching motions of the vehicle traveling over a stationary random road surface. A man-seat model was also incorporated into the simulation. Vehicle response to road irregularities has been studied by assuming two different roads for loaded and unloaded cases. Numerical results are presented for vehicle, showing system eigenvalues, power spectral densities and root mean square values of the linear and angular accelerations and displacements. Vehicle acceleration response is compared with the ISO riding comfort standard. All results for the loaded and unloaded cases and for smooth and rough roads indicated that an uncomfortable ride would result from vehicle response.

80-1788

Roll Dynamics of Commercial Vehicles

M.K. Verma and T.D. Gillespie

Engrg. Mechanics Dept., General Motors Research Labs., Warren, MI 48090, Vehicle Struc. Dyn., 9 (1), pp 1-17 (Jan 1980) 12 figs, 2 tables, 8 refs

Key Words: Articulated vehicles, Cargo transportation, Ride dynamics

An analytical model is developed for studying the roll dynamics of commercial vehicles. Large displacements and rotations are accounted for in this nonlinear model so that it can be used for the study of roll dynamics well beyond the limits of wheel lift-off. The model is used to illustrate some of the dynamic phenomena in vehicle rollover, especially the interactive coupling between the roll and the vertical modes of motion. The influence of suspension backlash on rollover resistance is demonstrated, and the phenomenon of roll motion resonance is illustrated to suggest new means for evaluated vehicle rollover sensitivity.

80-1789

Nonlinear Contact Geometry Effects on Wheelset Dynamics

T.D. Burton and A.M. Whitman

Dept. of Mech. Engrg., Washington State Univ., Pullman, WA 99164, J. Appl. Mech., Trans. ASME, 47 (1), pp 155-160 (Mar 1980) 3 figs, 18 refs

Key Words: Interaction: rail-wheel, Wheelsets

The nonlinear dynamic behavior of a simply restrained railway vehicle wheelset on tangent track is investigated. Non-

linearities due to the kinematics of wheel/rail contact (excluding flange contact) and creep force variation with creepage are considered for mildly noncircular wheel and rail profiles.

80-1790

A Note of the Lyapunov Stability Analysis of a Linear Railway Wheelset

A.B. Perlman and C.L. Dym

Dept. of Mech. Engrg., Tufts Univ., Medford, MA, Vehicle Syst. Dyn., 9 (2), pp 61-68 (Apr 1980) 1 fig, 9 refs

Key Words: Interaction: rail-wheel, Critical speeds, Lyapunov's method

In this paper a Lyapunov function is generated for the linearized equations governing a steel wheelset on steel rails. Application of Ingwerson's method for constructing Lyapunov functions is reported. The stability criteria applied to this function yield a closed-form expression for the critical forward speed of the wheelset.

AIRCRAFT

(Also see Nos. 1756, 1895, 1899, 1919, 1969, 1970, 1977, 1979, 1980)

80-1791

A Flutter-Speed Formula for Wings of High Aspect Ratio

T. Niblett

Structures Dept., Royal Aircraft Establishment, Farnborough, UK, AGARD Low Cost Aircraft Flutter Clearance, 14 pp (Sept 1979)
N80-15174

Key Words: Aircraft wings, Flutter

Flutter-speed formulae for unswept wings of high aspect ratio and not carrying concentrated masses are derived. A high aspect ratio wing was defined as one whose fundamental torsional frequency is well above its first overtone flexural frequency.

80-1792

Low Cost Aircraft Flutter Clearance

Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France, Rept. No. ISBN-92-835-0245-0; AGARD-CP-278, 110 pp (Sept 1979)
N80-15141

Key Words: Aircraft, Flutter

An evaluation of the usage of low cost aircraft flutter clearance procedures is presented . Some results occurring from such procedures (weight efficiency, safety, flight incidents, and overall costs) were discussed relative to those from methods using advanced state of the art.

80-1793

Comparison of International Flutter Requirements and Flutter Freedom Substantiation of Light Aircraft in the USA

H.F. Hunter and G.E. Goodblood

Lockheed-Georgia Co., Marietta, GA, AGARD Low Cost Aircraft Flutter Clearance, 10 pp (Sept 1979)
N80-15142

Key Words: Aircraft, Flutter, Specifications

A comparison of current flutter specification requirements for light aircraft produced by NATO and other free-world countries is presented as well as an overview of flutter substantiation procedures presently used in the USA by the Federal Aviation Administration. Current flutter assessment procedures for light aircraft parallel very nearly those for transport-type aircraft.

80-1794

The State-of-the-Art of Flutter Substantiation Procedures Among US General Manufacturers

E.H. Hooper

Structural Dynamics Dept., Beech Aircraft Corp., Wichita, KS, AGARD Low Cost Aircraft Flutter Clearance, 19 pp (Sept 1979)
N80-15143

Key Words: Aircraft, Flutter, Statistical analysis, Wind tunnel tests

An overview is presented of the state of flutter substantiation procedures among U.S. general aviation manufacturers to serve as a guide to the small plane designer in the prevention of flutter, aileron reversal, and wing divergence.

80-1795

An Empirical Approach for Checking Flutter Stability of Gliders and Light Aircraft

F. Kiessling

Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, West Germany, AGARD Low Cost Aircraft Flutter Clearance, 17 pp (Sept 1979)

N80-15144

Key Words: Aircraft, Flutter, Stability

Data of flutter accidents and computations of gliders and light aircraft are presented, and the empirical rules of a simplified flutter investigation are applied. A procedure for checking the flutter stability of small airplanes is proposed, which takes into account the varying levels of knowledge with conventional and unconventional designs.

80-1796

Dynamic Identification of Light Aircraft Structures and Their Flutter Certification

G. Piazzilo and J. Meurzec

Office National d'Etudes et de Recherches Aerospatiales, Paris, France, AGARD Low Cost Aircraft Flutter Clearance, 19 pp (Sept 1979)

N80-15145

Key Words: Flutter, Aircraft

For determining specifications of light aircraft structures for their aeroelastic certification, the following points are discussed: application of fast identification methods and of technological means to be implemented during the tests; exploitation of flutter onset calculations; development of mixed methods, based on the theoretical definition of the participation of the control surfaces in the structural modes revealed by the test, with a view to palliating the possible orthogonally defects of the experimental modal basis on which the definitive flutter prediction calculations are established; and methods and techniques used during the aeroelastic flight test, carried out in the particular cases where flutter certification cannot be based only on the calculation file because of insufficient safety margins.

80-1797

General Theory of Aerodynamic Instability and the Mechanism of Flutter

T. Theodorsen

Langley Aeronautical Lab., National Advisory Committee for Aeron., Langley Field, VA, Rept. No. NACA-496, pp 291-311 (Dec 1979)

N80-15047

Key Words: Flutter, Airfoils, Aircraft wings

The aerodynamic forces on an oscillating airfoil or airfoil-aileron combination of three independent degrees of freedom were determined. The mechanism of aerodynamic instability for known air forces was analyzed.

80-1798

The Loads at Landing Impact (Die Lasten des Landestosses)

K. Konig

VFW-Fokker G.m.b.H., Hundefeldstrasse 1-5, 2800 Bremen 1, Z. Flugwiss, 3 (6), pp 344-360 (Nov/Dec 1979) 29 figs, 9 refs

(In German)

Key Words: Aircraft, Landing gear, Impact shock

A comprehensive calculation method for landing gear loads is presented. Separate examinations must be carried out for each type of aircraft to establish which special physical characteristics of the landing gear and aircraft are essential in the landing impact calculation and which are insignificant. The special structural elasticity of the shock strut and appropriate tire mechanics are of particular importance in this connection. The expenditure for reliable and sound calculations for large aircraft is small in comparison with the assertive value and use of the results of such calculations.

80-1799

Evaluation of Seating and Restraint Systems Conducted During Fiscal Year 1978.

R.F. Chandler and E.M. Trout

Civil Aeromedical Inst., Oklahoma City, OK, Rept. No. AD-A074881; FAA-AM-79-17, 228 pp (June 1979)

N80-13014

Key Words: Crash research (aircraft), Safety restraint systems, Aircraft

Results are presented of test programs to investigate the performance of prototype or operational seating and restraint

systems relative to their ability to provide protection against crash injury and to validate the performance of the FAA Seat Occupant Model: Light Aircraft.

80-1800

A Simplified Ground Vibration Test Procedure for Sailplanes and Light Aircraft

N. Niedbal

Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, West Germany, AGARD Low Cost Aircraft Flutter Clearance, 11 pp (Sept 1979)
N80-15146

Key Words: Aircraft, Beams, Modal analysis, Vibration tests

A test procedure to obtain all characteristic modal data for an aeroelastic analysis is presented. It is shown that by taking into consideration the beam-like structural behavior of such aircraft, and the comparatively small bandwidth of the design variables, substantial simplifications are possible when the dynamic behavior of similar aircraft structures is known. The mechanical steering mechanism of the control surfaces causes high damping and nonlinear effects, which require a separate examination and analysis of the control surfaces.

80-1801

The Use of Strip Theory in the Dynamics of Deformable Aircraft

D.L. Woodcock

Royal Aircraft Establishment, Farnborough, UK, Rept. No. RAE-TM-Struct-933; BR66481, 120 pp (Aug 1978)
N80-13035

Key Words: Aircraft, Lagrange equations

A detailed formulation of the equations of motion of a deformable aircraft is given. The development is from Lagrange's equations for an inertial frame and is made in terms of the position, orientation, force, and inertia properties of narrow strips of the aircraft which lie force and aft in the unperturbed state. The latter is one of constant linear velocity and zero angular velocity. Particular account is taken of the deformation and loading in the unperturbed state.

80-1802

Quiet Clean Short-Haul Experimental Engine (QCSEE) Over-The-Wing (OTW) Propulsion Systems Test Report. Volume 4: Acoustic Performance

D.L. Stimpert

General Electric Co., Cincinnati, OH, Rept. No. R77AEG476; NASA-CR-135326, 144 pp (Feb 1979)
N80-15118

Key Words: Acoustic tests, Aircraft noise, Noise measurement

A series of acoustic tests were conducted on the over the wing engine. These tests evaluated the fully suppressed noise levels in forward and reverse thrust operation and provided insight into the component noise sources of the engine plus the suppression achieved by various components.

80-1803

Effects of Sound Level Fluctuations on Annoyance Caused by Aircraft-Flyover Noise

D.A. McCurdy

NASA, Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1576; L-13181, 40 pp (Dec 1979)
N80-13880

Key Words: Aircraft noise, Human response

A laboratory experiment was conducted to determine the effects of variations in the rate and magnitude of sound level fluctuations on the annoyance caused by aircraft-flyover noise. The effects of tonal content, noise duration, and sound pressure level on annoyance were also studied.

80-1804

Experimental Study of Sound Radiation from a Subsonic Jet in Simulated Motion

J.C. Yu and N.R. Dixon

NASA Langley Research Center, Hampton, VA, AIAA J., 18 (4), pp 427-433 (Apr 1980) 15 figs, 1 table, 29 refs

Key Words: Aircraft noise, Sound waves

An experiment has been conducted in an anechoic free-jet facility to determine the effect of motion on noise radiation from a subsonic unheated model jet.

80-1805

Evaluation of Approximate Methods for the Prediction of Noise Shielding by Airframe Components

W.F. Ahtye and G. McCulley
Ames Research Center, NASA, Moffett Field, CA,
NASA-TP-1004; A-698, 105 pp (Jan 1980)
N80-15129

Key Words: Aircraft noise, Plates, Rectangular plates, Circular cylinders, Noise barriers

An evaluation of some approximate methods for the prediction of shielding of monochromatic sound and broadband noise by aircraft components is reported. Anechoic-chamber measurements of the shielding of a point source by various simple geometric shapes were made and the measured values compared with those calculated by the superposition of asymptotic closed-form solutions for the shielding by a semi-infinite plane barrier. The shields used in the measurements consisted of rectangular plates, a circular cylinder, and a rectangular plate attached to the cylinder to simulate a wing-body combination.

80-1806

Landing Approach Airframe Noise Measurements and Analysis

P.L. Lasagna, K.G. Mackall, F.W. Burcham, Jr. and T.W. Putnam
Hugh L. Dryden Flight Research Center, NASA, Edwards, CA,
Rept. No. NASA-TP-1602, 36 pp (Jan 1980)
N80-15028

Key Words: Aircraft noise, Noise measurement, Landing

Flyover measurements of the airframe noise produced by the AeroCommander, JetStar, CV-990, and B-747 airplanes are presented for various landing approach configurations. Empirical and semiempirical techniques are presented to correlate the measured airframe noise with airplane design and aerodynamic parameters.

80-1807

A Study of Partial Coherence for Identifying Interior Noise Sources and Paths on General Aviation Aircraft

J.T. Howlett
Langley Research Center, NASA, Hampton, VA,
Rept. No. NASA-TM-80197, 17 pp (Dec 1979)
N80-15874

Key Words: Aircraft, Noise source identification, Noise path diagnostics

The partial coherence analysis method for noise source/path determination is summarized and the application to a two input, single output system with coherence between the inputs is illustrated. The augmentation of the calculations on a digital computer interfaced with a two channel, real time analyzer is also discussed. The results indicate possible sources of error in the computations and suggest procedures for avoiding these errors.

80-1808

Advanced Turbo-Prop Airplane Interior Noise Reduction-Source Definition

B. Magliozzi and B.M. Brooks
Hamilton Standard, Windsor Locks, CT,
Rept. No. NASA-CR-159668, 90 pp (Oct 1979)
N80-13882

Key Words: Aircraft noise, Interior noise, Noise measurement, Noise reduction, Wind tunnel tests

Acoustic pressure amplitudes and phases were measured in model scale on the surface of a rigid semicylinder mounted in an acoustically treated wind tunnel near a prop-fan (an advanced turboprop with many swept blades) model. Operating conditions during the test simulated those of a prop-fan at 0.8 Mach number cruise. Acoustic pressure amplitude and phase contours were defined on the semicylinder surface. Measurements obtained without the semi-cylinder in place were used to establish the magnitude of pressure doubling for an aircraft fuselage located near a prop-fan.

80-1809

Helicopter Noise Impact

R.G. Edwards, A.B. Broderson, and C.W. Johnson
Watkins and Associates, Inc., Lexington, KY,
S/V Sound Vib., 14 (3), pp 20-25 (Mar 1980) 6 figs, 3 tables, 6 refs

Key Words: Helicopter noise, Noise reduction

To evaluate the environmental noise impact of civil helicopters, areas along the Gulf Coast of Louisiana and Texas, identified as those in the U.S. characterized by the "heaviest of helicopter activity," were visited and environmental noise measurements taken.

80-1810

Effect of Noise Spectra and a Listening Task Upon Passenger Annoyance in a Helicopter Interior Noise Environment

S.A. Clevenson and J.D. Leatherwood

NASA, Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1590; L-13233, 26 pp (Dec 1979)

N80-13769

Key Words: Helicopter noise, Interior noise, Human response

The effects of helicopter interior noise on passenger annoyance were studied. Both reverie and listening situations were studied as well as the relative effectiveness of several descriptors (i.e., overall sound pressure level, A-weighted sound pressure level, and speech interference level) for quantifying annoyance response for these situations. The noise stimuli were based upon recordings of the interior noise of a civil helicopter research aircraft.

80-1811

Evaluation of Helicopter Noise Due to Blade-Vortex Interaction for Five Tip Configurations

D.R. Hoad

Langley Research Center, NASA, Langley Station, VA, Rept. No. AVRADCOM-TR-80-B1, NASA-TP-1608, 80 pp (Dec 1979)

N80-14840

Key Words: Helicopter noise, Rotor blades, Geometric effects

The effect of tip shape modification on blade vortex interaction induced helicopter blade slap noise was investigated. Simulated flight and descent velocities which have been shown to produce blade slap were tested. Aerodynamic performance parameters of the rotor system were monitored to ensure properly matched flight conditions among the tip shapes. A detailed acoustic evaluation on the same rotor system of the relative applicability of the various tip configurations for blade slap noise reduction is provided.

80-1812

Investigation of the Oscillatory and Flight Behavior of Rotor Systems in Relation with Atmospheric Turbulence (Untersuchungen zum Schwingungs- und Flugverhalten von Hubschraubern unter atmosphaerischer Turbulenz)

H. Dahl and D. Weger

Messerschmitt-Boelkow-Blohm G.m.b.H., Munich, West Germany, Rept. No. BMVG-FBWT-79-5, 72 pp (1979)

N80-14142

(In German)

Key Words: Helicopters, Helicopter rotors, Turbulence, Statistical analysis

The effects of stochastic atmospheric disturbances on the performance of various helicopter rotor systems was investigated in order to determine their gust sensitivity. A statistical description of turbulent excitations which permits sufficiently accurate simulation of helicopter oscillatory behavior resulting from gust disturbances was developed. Results show that during low altitude flight and slow speed flight the gust vector distribution over the helicopter is very nonuniform.

80-1813

Unsteady Flow and Dynamic Response Analyses for Helicopter Rotor Blades

T. Bratanow

Wisconsin Univ., Milwaukee, WI, Rept. No. NASA-CR-159190, 30 pp (Nov 1979)

N80-14355

Key Words: Helicopter rotors, Rotary wings, Aerodynamic loads

Research is presented on helicopter rotor blade vibration and on two and three dimensional analyses of unsteady incompressible viscous flow past oscillating helicopter rotor blades.

80-1814

Math Modeling and Computer Mechanization for Real Time Simulation of Rotary-Wing Aircraft

R.M. Howe

Dept. of Aerospace Engrg., Michigan Univ., Ann Arbor, MI, Rept. No. NASA-CR-162400, 21 pp (Mar 1979)

N80-10137

Key Words: Helicopters, Digital simulation

Mathematical modeling and computer mechanization for real time simulation of rotary wing aircraft is discussed. Error analysis in the digital simulation of dynamic systems, such

as rotary wing aircraft is described. The method for digital simulation of nonlinearities with discontinuities, such as exist in typical flight control systems and rotor blade hinges, is discussed.

MISSILES AND SPACECRAFT

80-1815

Equilibrium and Liapunov Stability of Flexible Damped Gravity Oriented Satellite

H.B. Havlani and S.K. Shrivastava
Indian Inst. of Science, Bangalore, India, Z. Flugwiss, 4 (1), pp 7-15 (1980) 3 figs, 15 refs

Key Words: Spacecraft, Stability, Lyapunov's method

The paper determines nontrivial equilibrium of an inertially coupled gravity stabilized damped flexible satellite. It shows that Rayleigh's quotient and method of test density function are useful for Liapunov stability analysis. However, associated Hessian matrices cannot be handled to generate stability plots over a range of parameters without facing prohibitive amount of algebra and computational burden. It analyzes stability about trivial equilibrium via integral coordinate approach.

BIOLOGICAL SYSTEMS

HUMAN

(See Nos. 1803, 1810)

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see No. 1784)

80-1816

Absorption Mechanism of Porous Material of a Sound Pulse

T. Nakamura, A. Nakamura, and R. Takeuchi
Inst. of Scientific and Industrial Research, Osaka Univ., Yamadakami, Suita, Osaka, Japan, Acustica, 44 (1), pp 1-9 (Jan 1980) 10 figs, 6 refs

Key Words: Acoustic absorption, Porous materials

Absorption mechanism of porous material for a sound pulse is analyzed by means of the Fourier transform of incident and reflected pulses.

80-1817

Propagation in Acoustically Absorbent Materials

M. Perulli and P.E. Doak
Office National d'Etudes et de Recherches Aerospatiales, Paris, France, In AGARD Special Course on Acoustic Wave Propagation, 6 pp (Aug 1979) N80-14865

Key Words: Acoustic absorption, Absobrbers (materials), Porous materials

Models for representing the dynamics of porous and other acoustically absorbent materials are reviewed. Propagation in significantly absorbent materials widely used in practice, or commonly occurring, for example, as outdoor ground surfaces, is discussed. Non-linear high amplitude effects and mean flow effects are briefly described.

80-1818

Criticism of Statistical Energy Analysis for the Calculation of Sound Insulation: Part 2 - Double Partitions

A. Elmallawany
Acoustics Dept., Building Res. Ctr., P.O. Box 1770, El-Tahreer St., Dokky, Cairo, Egypt, Appl. Acoust., 13 (1), pp 33-41 (Jan/Feb 1980) 4 figs, 10 refs

Key Words: Acoustic absorption, Sound transmission loss, Statistical energy methods

Sound transmission loss of a double leaf partition, calculated earlier by means of statistical energy analysis method, is compared to measured values in this paper. In addition, the statistical energy method is compared to classical methods, and its advantages and disadvantages are discussed.

80-1819

A Simple Method for Predicting the Traffic Noise Reduction by Finite Barriers

R.J. Beracha

Inst. of Hygienne and Occupational Health, Sofia 1431, Bulgaria, Acustica, 44 (1), pp 23-26 (Jan 1980) 9 figs, 6 refs

Key Words: Noise reduction, Traffic noise, Noise barriers

A practical method for predicting the traffic noise reduction by multiple finite barriers has been proposed. Differences not more than 3 dB(A) between measured and predicted values of the traffic noise reduction by multiple residential buildings were observed.

80-1820

Calculation of the Specific Normal Impedance of Perforated Facing-Porous Backing Constructions

K.P. Byrne

School of Mech. and Industrial Engrg., The Univ. of New South Wales, P.O. Box 1, Kensington, NSW 2033, Australia, Appl. Acoust., 13 (1), pp 43-55 (Jan/Feb 1980) 6 figs, 10 refs

Key Words: Acoustic absorption, Porous materials, Acoustic impedance

Two methods for analyzing perforated facing-porous backing sound absorber systems are presented which allow the specific normal impedance to be evaluated on a digital computer. One method is used for each of the two types of construction considered. The first type of construction is characterized by the fact that there is a gap of at least one diameter of the hole in the perforated facing between the facing and the backing. The second type of construction is characterized by the fact that there is no such gap. Empirical laws are used to describe the acoustical properties of the porous materials. A comparison is made between predicted and measured specific normal impedances to indicate the accuracy likely to be achieved.

80-1821

Do Locally Reacting Acoustic Liners Always Behave as They Should?

T. Zandbergen

National Aerospace Lab., Amsterdam, Netherlands, AIAA J., 18 (4), pp 396-397 (Apr 1980) 4 figs, 4 refs

Key Words: Acoustic linings, Helmholtz resonators

It is shown that different behavior arises when neighboring cells are interconnected (e.g., by water drain holes) or when the cell cross dimensions are not small enough with respect to acoustic wavelength. The assumption of local reaction is then violated and the liner intended to be locally reacting will not behave as it should, that is, not as expected. In these cases the two-microphone technique of in-situ impedance measurement will provide erroneous data. Further, it is shown that when using the two-microphone technique on really locally reacting liners the location of the surface microphone has to be chosen carefully in order to provide accurate data.

80-1822

Controlling Noise and Reverberation with Acoustical Baffles

R.S. Hudson

Building Products Research Unit, Armstrong Cork Co., Lancaster, PA, Plant Engr., 34 (8), pp 131-135 (Apr 17, 1980) 4 figs, 5 tables

Key Words: Noise barriers

The selection, installation and economics of acoustic baffles are discussed.

80-1823

Beamlike Dynamic Vibration Absorbers

J.C. Snowdon and M.A. Nobile

Applied Research Lab., Pennsylvania State Univ., PA 16802, Acustica, 44 (2), pp 98-108 (Feb 1980) 14 figs, 4 tables, 20 refs

Key Words: Dynamic vibration absorption (equipment), Beams, Cantilever beams

The performance of several beamlike dynamic vibration absorbers is analyzed and, in one case, confirmed by experiment. The dynamic absorbers are employed to suppress the transmissibility at resonance across a simple mass-spring vibrator, a stanchion, and a simply supported rectangular panel. The absorbers comprise either single or double cantilever beams that are mass loaded at their free ends, or clamped-clamped beams that are centrally mass loaded. Generally,

the beams provide both the absorber stiffness and damping although, once, the beams are considered to possess little damping, supplemental viscous damping is introduced by dashpots that link the absorber masses to the vibrating primary system of concern. Graphical or tabular design information is specified for the absorbers in each situation considered. Analyses are based throughout on the Bernoulli-Euler beam and thin-plate theories without simplification. In several of the situations analyzed, transmissibility curves are calculated to emphasize that the beamlike absorbers are broadly effective.

80-1824

About an Application of the Fresnel Integrals for Calculating the Sound Reduction by Absorbing Screens

R.J. Beracha
Inst. of Hygienne and Occupational Health, Boul. Dim. Nestorov 15, Sofia 1431, Bulgaria, Acustica, 44 (2), pp 109-112 (Feb 1980) 8 figs, 5 refs

Key Words: Noise reduction, Acoustic absorption

Formulas for calculating the sound reduction by absorbing screens with a rectangular finite and infinite opening are presented. They are based on the approximate Fresnel-Kirchhoff diffraction theory.

TIRES AND WHEELS

(Also see Nos. 1789, 1911)

80-1825

Tyre Factors and Front Wheel Vibrations

H.B. Pacejaka
Dept. of Mech. Engrg., Delft Univ. of Technology, The Netherlands, Intl. J. Vehicle Des., 1 (2), pp 97-119 (Feb 1980) 27 figs, 8 refs

Key Words: Tire characteristics, Wheels

An extensive survey is given of both the analyses of in-plane and out-of-plane tire dynamical performance. The in-plane tire response model incorporates the highly important variation of the effective rolling radius with changing tire deflection. Theoretical and experimental plots are shown for the response to fluctuations in vertical axle position and in tire radius (out-of-roundness). The out-of-plane tire model is based on the well-known taut string model. Tire mass effects have been accounted for in an approximative manner. Experimental frequency response plots show good correspondence with theoretical findings. A simple front wheel suspension system showing three degrees of freedom illustrates the use of the tire model.

80-1826

A Comparison of Tyre Representations in a Simple Wheel Shimmy Problem

R.S. Sharp and C.J. Jones
Dept. Mech. Engrg., Univ. of Leeds, Vehicle Syst. Dyn., 9 (1), pp 45-57 (Jan 1980) 7 figs, 10 refs

Key Words: Wheel shimmy, Tires, Digital simulation, Differential equations

A simple system capable of wheel shimmy is analyzed in three different ways and the results are compared.

BLADES

(See Nos. 1754, 1933)

BEARINGS

(Also see Nos. 1748, 1752)

80-1827

Discrete-Time Modelling of a Squeeze-Film Bearing

R. Stanway, C.R. Burrows, and R. Holmes
The Univ. of Sussex, Brighton, J. Mech. Engrg. Sci., 21 (6), pp 419-427 (Dec 1979) 6 figs, 18 refs

Key Words: Bearings, Squeeze-film bearings

This paper describes the application of a discrete-time approach to the estimation of the linearized velocity coefficients of a squeeze-film bearing. It is assumed that motions in the vertical and horizontal directions are uncoupled. Sampled observations from laboratory experiments are processed digitally to yield estimates of the parameters in a vector-matrix difference equation. A transformation applied to this equation produces direct estimates of the oil-film coefficients. Verification of the estimated coefficients is achieved through the prediction of the dynamical behavior of the bearing. In this way, the effectiveness of the experimental models is assessed and compared with predictions based upon short, uncavitated bearing theory.

80-1828
Fatigue Initiation in Thin-Wall Journal Bearings
J.K. Blundell
Univ. of West Indies, St. Augustine, Trinidad, West Indies, ASLE, Trans., 23 (2), pp 131-140 (Apr 1980) 8 figs, 2 tables, 6 refs

Key Words: Bearings, Journal bearings, Fatigue life

Fatigue failure of dynamically loaded plain bearings is investigated and the position of failure is correlated with major hydrodynamic oil film characteristics, e.g. peak pressure, temperature distribution and minimum oil film thickness.

80-1829
The Use of Free Rolling Cylindrical Roller Bearings in Stationary Drive Construction (Über die Anwendung vollrolliger Zylinderrollenlager im stationären Getriebebau)
J. Markowski
Industriewerk Schaeffler OHG, Herzogenaurach, Germany, Konstruktion, 32 (3), pp 113-117 (Mar 1980) 9 figs
(In German)

Key Words: Bearings, Roller bearings

Free rolling cylindrical roller bearings for output shafts and for main drive shafts of stationary drives and planetary gear drives are described, with a particular emphasis on shaft deflection and axial force absorption.

80-1830
Analysis of Step Journal Bearings - Finite Length, Stability
J.C. Nicholas and P.E. Allaire
Univ. of Virginia, Charlottesville, VA 22901, ASLE, Trans., 22 (2), pp 197-207 (Apr 1979) 15 figs, 37 refs

Key Words: Journal bearings, Turbulence, Stiffness coefficients, Damping coefficients, Sommerfeld number

The finite length pressure dam step bearing is analyzed neglecting step inertia effects but including the effects of turbulence over the entire bearing surface. Load curves for sample step bearing designs are given along with stiffness and damping coefficients. Bearing stability threshold curves for various pressure dam bearing geometries are compared to plain journal, two-axial groove and grooved lower-half bearings.

80-1831
Spherical Plain Thrust Bearings Assist in Preventing Earthquake Damage
J.F. Messenger and W.K. Chapman
SKF Wellington, Ball Bearing J., 202, pp 21-23 (Feb 1980) 3 figs

Key Words: Bearings, Electric power plants, Seismic design

A unique support arrangement for the smoothing reactors of high voltage equipment is described. These reactors are mounted on porcelain columns 2,6 m high and maintenance-free spherical plain thrust bearings are incorporated at the attachment points. Together with deformable beams, these bearings eliminate bending moments during earthquakes.

GEARS

80-1832
Influence of Torsional Vibrations of a Gear Train System on the Tooth Load
Y. Furuya, K. Seto, K. Yamada, and M. Yamanouchi
National Defense Academy, Yokosuka, Japan, Bull. JSME, 23 (176), pp 300-308 (Feb 1980) 16 figs, 3 tables, 9 refs

Key Words: Gears, Torsional vibration

The dependency of the natural frequencies of the gear system on the dynamic increment in the tooth load is investigated experimentally and theoretically under two different operating conditions. It is shown that under regulated operating conditions, the dynamic increment in the tooth load is dominated by a specific natural frequency of the gear system; while under rough operating conditions, the dynamic increment is closely connected with natural frequencies of the gear system.

80-1833
Analysis of Dynamic Tooth Load on Planetary Gear
T. Hidaka, Y. Terauchi, and M. Fujii
Faculty of Engrg., Yamaguchi Univ., Tokiwa-Dai, Ube, Japan, Bull. JSME, 23 (176), pp 315-323 (Feb 1980) 10 figs, 1 table, 13 refs

Key Words: Gears, Gear teeth

Vibration of a single-stage Stoeckicht planetary gear (Type 2K-H) constructed with spur gears was investigated, and

the fillet stress, the dynamic tooth load and the load distribution were calculated. The calculated results nearly coincide with the measured ones.

80-1834
Misaligned Gear Couplings (Nichtfluchtende Zahnkupplungen)
R. Fleiss
Albert Tschan GmbH & Co. Kg, Neunkirchen, Germany, Konstruktion, 32 (3), pp 96-100 (Mar 1980) 8 figs, 1 table, 18 refs
(In German)

Key Words: Gear couplings, Alignment

Gear couplings permit a certain radial, angular and axial displacement required by the design. Yet, in practice they are usually aligned, even though that makes them more difficult to lubricate. On the other hand, the deflection means relative motion and thus loss of friction as well as reduction in the transmitted torque. This paper discusses the required torque return as a function of relative velocity as well as the mechanical efficiency of gear coupling.

COUPLINGS

(See No. 1834)

FASTENERS

80-1835
Special Fastener "Eliminates" Brake Failures
Des. News, 36 (7), pp 128-129 (April 1980)

Key Words: Joints (junctions), Screws, Brakes (motion arresters), Fatigue life

Special prevailing-torque, self-locking shoulder screws are described which provide a vibration-resistant high fatigue-strength (tension) joining of pressure plates and air cylinder components of pneumatic brakes.

LINKAGES

80-1836
Evaluation of Dynamically Riveted Joints
B.P. Leftheris, H. Eidinoff, and R.E. Hooson
Res. Dept., Grumman Aerospace Corp., Bethpage, NY, Rept. No. RE-587, NADC-77202-30, 71 pp (July 1979)
AD-A077 223/6

Key Words: Joints (junctions), Crack propagation

The performance of stress wave driven rivet installations is evaluated in terms of crack growth arresting capability, using precracked specimens subjected to constant amplitude and spectrum fatigue loading. Rivets installed in pre-cracked holes using the Grumman Stress Wave Riveter (SWR) are shown to be effective in arresting crack growth. Residual stresses resulting from rivet coldwork are determined and the effective stress intensity factor K sub I is calculated. It is concluded that Stress wave rivet installations offer significant potential weight saving for structures designed to a damage tolerant criteria.

80-1837
Friction Springs and Tension Joints - Their Characteristics and Applications (Reibungsfedern und Spannverbindungen - Eigenschaften und Anwendungsmöglichkeiten)
H. Schafer
VDI Z, 121 (22), pp 1129-1135 (Nov 1979) 28 figs, 4 refs
(In German)

Key Words: Joints (junctions), Springs

Some types of tension joints recently developed with significant advantages in certain applications are discussed.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

80-1838
High-Frequency Yarn Tension Variations in Spinning
E. Dyson and G. Afshari
Univ. of Bradford, Bradford, UK, J. Engr. Indus., Trans. ASME, 102 (1), pp 45-50 (Feb 1980) 5 figs, 2 tables, 3 refs

Key Words: Yarns, Yarn spinning, Statistical analysis, Spectrum analysis

An experimental investigation of the variations in yarn tension during both ring and rotor open-end spinning which have frequencies equal to, or greater than, the rotational speed of the system is described. Typical results are illustrated and discussed both in terms of statistical parameters such as the coefficient of variation and in terms of their spectra. Tension variations during rotor spinning are shown to have, in general, a much less pronounced periodic structure than the corresponding variations during ring spinning.

CABLES

(See No. 1851)

BARS AND RODS

80-1839

Wave Propagation in Prestressed Curved Rods

M. Farshad

Dept. of Civil Engrg., Univ. of Shiraz, Shiraz, Iran, ASCE J. Engr. Mech., 106 (2), pp 395-408 (Apr 1980) 9 figs, 27 refs

Key Words: Rods, Curved rods, Wave propagation, Arches, Rings

The vibration and harmonic wave propagation in prestressed curved rods is theoretically studied. The equations of spatial elastic rods subjected to a generally deformation-dependent loading are employed and are specialized to prestressed planar circular arch equations. Torsional-lateral and extensional-flexural modes of motion of prestressed circular arches and rings are then investigated. The dispersion relations for each mode of motion are determined and are plotted for certain values of loading parameter. The loading considered in these problems consists of dead force, hydrostatic pressure, and centrally directed pressure loading.

80-1840

The Effect of Shear Deformation on the Nonlinear Vibration of Bars (Der Einfluss der Schubverformung auf die Nichtlineare Schwingung von Stäben)

N.X. Hung

Technical University of Hanoi, Rev. Roumaine Sci. Tech., Méc. Appl., 24 (5), pp 833-839 (Sept/Oct 1979) 2 figs, 3 refs

(In German)

Key Words: Bars, Nonlinear systems, Transverse shear deformation effects

The nonlinear forced vibration of bars is investigated. It is shown, that if shear deformation is taken into consideration the vibration equations of bars with nonlinear material properties have an entirely different form, thus resulting in different types of vibrations.

80-1841

Equations of Motion of the Spatial Curved Bars, Kinematic Elements of Mechanisms

M. Buculei and D. Marghitu

Univ. of Craiova, Romania, Rev. Roumaine Sci. Tech., Méc. Appl., 24 (5), pp 757-763 (Sept/Oct 1979) 1 fig, 5 refs

Key Words: Bars, Curved beams, Hamiltonian principle

The equations of motion in the displacement of wry curved bars in spatial rotor translation are derived from the generalized formula of kinetic energy by means of Hamilton's variational principle. The equations are required in the elastokinematic and elastodynamic analysis of spatial mechanisms.

BEAMS

(Also see Nos. 1761, 1762, 1800)

80-1842

Stability of a Beam on an Elastic Foundation Subjected to a Nonconservative Load

Z. Celep

Faculty of Engrg. and Architecture, Technical Univ., Istanbul, Turkey, J. Appl. Mech., Trans. ASME, 47 (1), pp 116-120 (Mar 1980) 5 figs, 8 refs

Key Words: Beams, Cantilever beams, Elastic foundations, Winkler foundations, Nonconservative forces, Stability

In this investigation, the influence of a Winkler type of elastic foundation on the stability of the cantilever beam subjected to a nonconservative load which consists of a vertical and a follower components is studied. In addition

to the common transverse foundation modulus, a rotatory foundation modulus is considered. Approximate solution is obtained by using Galerkin's method. Numerical calculations are reported and displayed for various combinations of the nonconservativeness parameter, transverse and rotatory modulus of the foundation, distance of the point of application of the load and that of the transverse spring. As a result of the numerical study unexpected feature of stability of the cantilever beam in contrast to the behavior of the column is identified.

80-1843

The Dynamically Loaded Circular Beam on an Elastic Foundation

D.E. Panayotounakes and P.S. Theocaris

National Technical Univ. of Athens, 5, K. Zographou St., Zographou, Athens 625, Greece, J. Appl. Mech., Trans. ASME, 47 (1), pp 139-144 (Mar 1980) 2 figs, 2 tables, 19 refs

Key Words: Beams, Elastic foundations, Natural frequencies, Harmonic excitation, Transverse shear deformation effects, Rotatory inertia effects

In this investigation an analytical treatment for the determination of the natural frequencies of a circular uniform beam on an elastic foundation, subjected to harmonic loads, is presented. This problem in the most general case of response is reduced to a system of six-coupled linear partial differential equations. The effects of rotatory inertia and transverse shear deformation are also included in the analysis. The problem is treated by considering the beam as a continuous system, as well as a discrete system. The aforementioned solution methodology is successfully demonstrated through several numerical examples.

80-1844

Strength Decay in R/C Beams under Load Reversals

C.F. Scribner and J.K. Wight

Univ. of Illinois, Urbana, IL, ASCE J. Struc. Div., 106 (4), pp 861-876 (Apr 1980) 12 figs, 3 tables, 17 refs

Key Words: Beams, Concretes, Reinforced concrete, Earthquake response

An experimental investigation to determine the effectiveness of intermediate longitudinal reinforcement in limiting shear strength decay of reinforced concrete members is presented. Test specimens consisted of fourteen exterior beam-column subassemblies. Variables included shear stress, percentage of beam transverse reinforcement, percentage of longitudinal reinforcement and shear span to depth ratio in addition to the presence of two layers of intermediate longitudinal reinforcement in half the specimens. Test results indicated that intermediate longitudinal reinforcement provided significant and useable improvement in shear strength retention for members with maximum shear stresses between three and six times the square root of the specified compression strength of concrete.

80-1845

Construction of a Dynamic Weight Function From a Finite-Element Solution for a Cracked Beam

H.J. Petroski, J.L. Glazik, and J.D. Achenbach

Engrg. Mechanics Program, Reactor Analysis and Safety Div., Argonne National Lab., Argonne, IL 60439, J. Appl. Mech., Trans. ASME, 47 (1), pp 51-56 (Mar 1980) 4 figs, 4 tables, 6 refs

Key Words: Beams, Cracked media, Finite element technique

An elastodynamic weight function for a cracked beam is shown to be determined by the elastodynamic stress intensity factor corresponding to a single crack-face loading of the beam. This weight function suffices to determine the time-dependent stress intensity factor corresponding to other dynamic loadings of the same cracked beam. The example of a center-cracked pinned-pinned beam serves to illustrate and verify the technique. The weight function is constructed from finite element results for the case of a step pressure distributed uniformly along the beam, and the case of a step load concentrated at the crack plane serves as an illustration of the efficacy of the weight function so constructed.

80-1846

Vibrations of Curved Spans for Mass Transit

T.P. Joseph and J.F. Wilson

Howard Needles Tammen and Bergendoff, Charleston, WV, ASCE J. Engr. Mech. Div., 106 (2), pp 255-272 (Apr 1980) 14 figs, 1 table, 9 refs

Key Words: Beams, Curved beams, Guideways, Moving loads, Mass transportation

Nondimensional dynamic responses of simple and multiply-supported, horizontally curved beams with moving loads are measured in laboratory-scale experiments. Effects of system parameters involving span stiffness, arc length, frequency, end support constraints, and various transit load speeds and

spacings are investigated. For critical combinations of certain parameters, adverse coupling of bending and torsional span responses are observed. For instance, as critical load speeds are approached, measured twist angles and bending strains at midspan approach unboundedness for multiple spans, but are bounded for equivalent simple spans placed end-to-end. Calculations based on Bernoulli-Euler curved beam theory (with negligible warping rigidity) complement these simple span measurements. Experiments also include multiple spans with up to 90° turns, subject to both transit point loads in tandem and sprung vehicles. Results are applicable to dynamic span designs for mass transit systems.

80-1847

Natural Frequency of Timoshenko Beam on Flexible Base

A.P. Papadopoulos and D.M. Trujillo

Holmes & Narver, Inc., Orange, CA, ASCE J. Engr. Mech. Div., 106 (2), pp 307-321 (Apr 1980) 8 figs, 3 tables, 9 refs

Key Words: Buildings, Beams, Elastic foundations, Natural frequencies, Euler beams, Timoshenko theory

The influence of base rotational and horizontal springs has been investigated for Euler and Timoshenko beams. The results were presented in terms of convenient dimensionless parameters so that the influence can be easily evaluated. The parameters were varied to cover the behavior of beams ranging from pure bending to pure shear. An example, demonstrating the use of the results to a multistory shear building, is included.

80-1848

On the Discontinuity of the Flutter Load for Various Types of Cantilevers

A.N. Kounadis and J.T. Katsikadelis

National Technical Univ. of Athens, Greece, Intl. J. Solids Struc., 16 (4), pp 375-383 (1980) 7 figs, 9 refs

Key Words: Flutter, Beams, Cantilever beams, Energy methods, Transverse shear deformation effects, Rotatory inertia effects

In this investigation, using an energy (variational) approach, the flutter instability for various types of elastically restrained uniform cantilevers carrying up to three concentrated masses and subjected to a follower compressive force, is presented. The effects of transverse shear deformation and rotatory inertia of the mass of the column and of the positioning of the concentrated masses with or without their rotational inertia, are also included in the analysis.

80-1849

Dynamics of Timoshenko Tubular Beams Conveying Fluid

B.M. Laithier

Ph.D. Thesis, McGill Univ., Canada (1979)

Key Words: Beams, Tubes, Fluid-filled containers, Timoshenko theory, Transverse shear deformation effects, Rotatory inertia effects

The dynamics of tubes conveying fluid with either steady or pulsating flow velocity is re-examined both theoretically and experimentally.

80-1850

Complex Moduli Derived from the Vibrations of a Timoshenko Beam

S.A. Paipetis, P.S. Theocaris, and C.A. Stassinakis

Dept. of Mechanics, National Technical Univ. of Athens, Athens 625, Greece, Acustica, 44 (1), pp 27-34 (Jan 1980) 7 figs, 23 refs

Key Words: Beams, Timoshenko theory, Viscoelastic media, Forced vibration

The forced motion of a viscoelastic Timoshenko beam was investigated over wide ranges of the parameters involved. Based on the results thus produced, a method was developed for the derivation of both extensional and shear complex moduli of the beam material from the same specimen when vibrated at two different lengths. It was found that after a proper parameter study, it was easy to seek for solutions at relatively low cost, e.g. as expressed in computer time. Further, it was found that the so-called "forced vibration methods" for the determination of the complex moduli of viscoelastic materials are practically operative in the area of resonance, where the effect of damping is predominant. Other effects such as of Poisson's ratio of the beam material and the mass of the driving device were investigated.

CYLINDERS

80-1851

An Analytical Study of the Dynamic Characteristics of Towed Flexible Cylinders

J.S. Tennant, S.E. Dunn, and J.S. Komrower
Dept. of Ocean Engrg., Florida Atlantic Univ., Boca Raton, FL, Rept. No. OE-7912, 98 pp (June 30, 1979)
AD-A077 273/1

Key Words: Cylinders, Submerged structures, Towed systems

The dynamic analysis of a long, thin cylinder under tow in a fluid medium is presented. The differential equation of motion is developed with the result taking the form of a fourth order, nonlinear relation. An order of magnitude analysis is performed to inspect the significance of the equation terms under various types of motion. The linearized form of the differential equation without the cross flow, drag term is analyzed for stability characteristics as a function of tow speeds, cylinder length and diameter and trailing end shape characteristics.

COLUMNS

80-1852
Dynamic Stability of Columns Subjected to Nonconservative Forces
J.J. Wu and J.D. Vasilakis
Large Caliber Weapon Systems Lab., Army Armament Research and Development Command, Watervliet, NY, Rept. No. ARLCB-TR-79030, AD-E440 053, 23 pp (Oct 1979)
AD-A078 920/6

Key Words: Columns, Dynamic stability, Nonconservative forces

The numerical results of a class of problems of linear elastic stability problems subjected to nonconservative forces and under various support conditions are presented. A single solution formulation by which these results have been obtained is described. Accuracy of these results compared with those reported in the literature is discussed.

FRAMES AND ARCHES
(Also see Nos. 1839, 1872)

80-1853
Dynamic Analysis of Reinforced Concrete Frame-Wall Structures
K. Emori and W. Schnobrich
Kajima Corp., Tokyo, Japan, Engrg. Struc., 2 (2), pp 103-112 (Apr 1980) 14 figs, 3 tables, 14 refs

Key Words: Frames, Walls, Reinforced concrete, Seismic response

The nonlinear response and failure mechanism of reinforced concrete frame-wall systems is investigated through the employment of a mathematical model. The mathematical model is composed of two mechanical models: a concentrated spring model used for the flexural behavior of beam and column type members and a multiple spring model used for the response of the wall system. Both account for inelastic behavior of reinforced concrete. The mathematical model is applied to a ten-story frame-wall system. The constituent members are replaced by one of the mechanical models whose stiffness characteristics reflect the inelastic properties and hysteresis tendencies of the member. The resulting equations are solved by a step by step time integration procedure. Computed results are compared with experimental results obtained from a structure tested on the Illinois earthquake simulator. The correlated results are then used to define the significant response characteristics.

80-1854
Seismic Response of Eccentrically Braced Frames
A.K. Jain and S.C. Goel
Univ. of Roorkee, Roorkee, India, ASCE J. Struc. Div., 106 (4), pp 843-860 (Apr 1980) 6 figs, 3 tables, 11 refs

Key Words: Frames, Braces, Seismic response

This study deals with eccentrically braced frames with a view: to define situations in which end moments in the bracing members dominate over axial forces and vice versa and to study their seismic response with different member proportions.

PLATES
(Also see Nos. 1761, 1762, 1887, 1896, 1904)

80-1855
Vibrations of Plates of Various Geometries
E.G. Williams

Ph.D. Thesis, Pennsylvania State Univ., 157 pp (1979)
UM 8006070 (See also No. 1610)

Key Words: Plates, Mechanical admittance

Point-driven, flat, thin aluminum plates of various geometries with free boundaries are studied in this thesis. This prediction is compared to the experimentally determined admittance.

80-1856

Transverse Vibrations of Circular Plates of Linearly Varying Thicknesses

R.O. Grossi and P.A.A. Laura
Inst. of Applied Mechanics, 8111 Base Naval Puerto Belgrano, Argentina, Appl. Acoust., 13 (1), pp 7-18 (Jan/Feb 1980) 7 figs, 5 tables, 4 refs

Key Words: Plates, Circular plates, Variable cross section, Flexural vibration

The title problem is solved using very simple polynomial coordinate functions and a variational approach. Rather general boundary conditions are assumed at the edge support. It is shown that the approach is valid for axi- and antisymmetric model configurations.

80-1857

Vibration of a Clamped Circular Plate Driven by a Noncentral Force

J.C. Snowdon
Applied Research Lab., Pennsylvania State Univ., University Park, PA 16802, J. Acoust. Soc. Amer., 67 (4), pp 1222-1231 (Apr 1980) 25 figs, 21 refs (See also Rept. No. ARL/PSU/TM-79-191, 57 pp, Oct 1979, AD-A078 785/3)

Key Words: Plates, Circular plates, Vibration response

Expressions are stated for the transmissibility and for the driving-point impedance of an internally damped circular plate with a clamped boundary that is driven by a vibratory point force at an arbitrary distance from the plate center. Expressions are also stated for the plate transmissibility and driving-point impedance when the plate is loaded at the arbitrary driving point either by a lumped mass, by a dynamic vibration absorber, or simultaneously by a lumped mass and a dynamic absorber. In all cases, representative calculations of transmissibility and impedance are plotted versus the square root of frequency. These curves clearly show the dependence of transmissibility and impedance on the plate damping factor and the extent of the mass loading. They also show the effectiveness of the dynamic absorber.

80-1858

Analysis of Free Vibration of Annular Plate of Variable Thickness by Use of a Spline Technique Method

T. Irie and G. Yamada
Faculty of Engrg., Hokkaido Univ., Sapporo, Bull. JSME, 23 (176), pp 286-292 (Feb 1980) 6 figs, 3 tables, 10 refs

Key Words: Plates, Rings, Variable cross section, Free vibration

The free vibration of an annular plate of radially varying thickness is analyzed using spline technique. Using this method the plate is divided into small ring-shaped elements and the transverse deflection of each element is expressed by a quintic spline function with unknown coefficients. These coefficients are determined and a frequency equation is derived in which the spline function satisfies the equation of motion of the plate at each dividing circle and boundary conditions at both edges. The method is applied to annular plates with linearly, parabolically and exponentially varying thickness; the natural frequencies and the mode shapes of the plates are calculated numerically and the effects of the varying thickness are discussed.

80-1859

Dynamic Plastic Response of Circular Plates with Transverse Shear and Rotatory Inertia

N. Jones and J.G. de Oliveira
Dept. of Ocean Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Appl. Mech., Trans. ASME, 47 (1), pp 27-34 (Mar 1980) 9 figs, 22 refs

Key Words: Plates, Circular plates, Plastic properties, Impact response (mechanical), Transverse shear deformation effects, Rotatory inertia effects

The response of a simply supported circular plate made from a rigid perfectly plastic material and subjected to a uniformly distributed impulsive velocity is developed herein. Plastic yielding of the material is controlled by a yield criterion which retains the transverse shear force as well as bending moments and the influence of rotatory inertia is included in the governing equations. Various equations and numerical

results are presented which may be used to assess the importance of transverse shear effects and rotatory inertia for this particular problem.

80-1860

Rectangular Plates on Linear Viscoelastic Foundations

K. Sonoda and H. Kobayashi
Dept. of Civil Engrg., Osaka City Univ., Sumiyoshiku, Osaka, Japan, ASCE J. Engrg. Mech. Div., 106 (2), pp 323-338 (Apr 1980) 3 figs, 6 tables, 17 refs

Key Words: Plates, Rectangular plates, Viscoelastic foundations

This paper deals with the quasistatic bending problems of the rectangular plates and the infinite strips on the linear viscoelastic foundations of the Kelvin, the Maxwell and the standard linear solid types. The general solutions for them are developed by using the eigenfunctions derived from a free lateral-vibration problem of the plates with the same geometries and the same boundary conditions and by utilizing the correspondence principle between linear elastic boundary value problem and linear viscoelastic one. Numerical results for the variations of the deflection in space and time are illustrated for a rectangular plate and an infinite strip on the viscoelastic foundation of the standard linear solid type.

80-1861

Effect of Transverse Shear and Rotatory Inertia on Large Amplitude Vibration of Anisotropic Skew Plates, Part 1 - Theory

M. Sathyamoorthy and C.T. Chia
Dept. of Civil Engrg., Univ. of Calgary, Calgary, T2N 1N4, Canada, J. Appl. Mech., Trans. ASME, 47 (1), pp 128-132 (Mar 1980) 1 fig, 13 refs

Key Words: Plates, Skew plates, Anisotropy, Transverse shear deformation effects, Rotatory inertia effects, Large amplitudes

A nonlinear vibration theory for anisotropic elastic skew plates is developed with the aid of Hamilton's principle. The effects of transverse shear deformation and rotatory inertia are included in the analysis. The differential equations formulated here readily reduce to the dynamic von Karman-type equations of skew plates when the shear and rotatory inertia effects are neglected. Solutions to these equations are presented for various boundary conditions in the second part of the paper.

80-1862

Effect of Transverse Shear and Rotatory Inertia on Large Amplitude Vibration of Anisotropic Skew Plates, Part 2 - Numerical Results

M. Sathyamoorthy and C.T. Chia
Dept. of Civil Engrg., Univ. of Calgary, Calgary, T2N, 1N4, Canada, J. Appl. Mech. Trans. ASME, 47 (1), pp 133-138 (Mar 1980) 11 figs, 18 refs

Key Words: Plates, Skew plates, Anisotropy, Transverse shear deformation effects, Rotatory inertia effects, Large amplitudes, Numerical analysis

Based on the single-mode analysis, solutions to the governing equations developed in Part 1 of this paper are presented for various boundary conditions by use of Galerkin's method and the Runge-Kutta numerical procedure. Excellent agreement is found between the present results and those available for nonlinear bending and large amplitude vibration of skew plates. The present results for moderately thick anisotropic skew plates indicate significant influences of the transverse shear deformation, orientation angle, skew angle, and side ratio on the large amplitude vibration behavior of certain fiber-reinforced composite skew plates.

80-1863

Flexural-Extension Behavior of Composite Piezoelectric Circular Plates

N.T. Adelman and Y. Stavsky
Dept. of Aeronautical Engrg., Techion, Israel Inst. of Tech., Haifa, Israel, J. Acoust. Soc. Amer., 67 (3), pp 819-822 (Mar 1980) 3 figs, 1 table, 11 refs

Key Words: Plates, Composite structures, Piezoelectric transducers, Vibration response

A plate-type theory is developed for the flexural-extensional vibratory response and static voltage deformation of heterogeneous piezoelectric circular transducer elements. Known results for homogeneous disks and bimorphs are shown to be special cases of the theory. Application is made to the design of simply supported metal-piezoceramic unimorph disks, and thin piezoceramic bimorph benders possessing metallic electrodes of non-negligible thickness.

80-1864

Difference of Structure-Borne-Sound Levels in Point Excitation of Plates or Excitation over a Large Area (Körperschall-Pegeldifferenzen bei Punktformig oder grossflächig über Federn angeregten Platten)

W. Kuhl

Am Reisenbrook 7 A, D-2000 Hamburg 67, Germany, Acustica, 44 (2), pp 81-97 (Feb 1980) 22 figs, 4 tables, 23 refs
(In German)

Key Words: Plates, Point source excitation

In point excitation of bending waves in a plate via springs the level difference rises below the lowest plate resonance corresponding to the mass impedance at 40 dB/decade of frequency, at higher frequencies corresponding to the frequency-independent bending-wave impedance of the plate at 20 dB/decade. Over a broad frequency range in between the impedance varies considerably due to the plate resonances and with it the level difference. This is shown by means of measurements in models and practical systems.

80-1865

On the Critical Frequency of Flat Plates in Dense Fluids (Zur Grenzfrequenz Ebener Platten in Dichten Medien)

D. Guicking and R. Boisch

Drittes Physikalisches Institut der Universitat Gottingen, Acustica, 44 (1), pp 41-45 (Jan 1980) 3 figs, 9 refs
(In German)

Key Words: Plates, Fluid-induced excitation, Sound propagation

The coincidence or critical frequency of flat plates - an important parameter for sound radiation - is usually derived from the thin-plate theory, and without accounting for the mass loading by the fluid. These simplifications are justified for plates in air, but not in dense fluids. It is shown that the inclusion of rotatory inertia and shear deflection alone raises the critical frequency of steel and aluminium plates in water by 21%, which figure grows, after inclusion of the mass load effect, to at least 34% (steel) or 52% (aluminium). The corrections are independent of plate thickness and apply, therefore, for thin plates, too.

80-1866

Surface Disintegration and Bubble Formation in Vertically Vibrated Liquid Column

H. Hashimoto and S. Sudo

Tohoku Univ., Sendai, Japan, AIAA J., 18 (4), pp 442-449 (Apr 1980) 15 figs, 20 refs

Key Words: Sloshing, Fluid-filled containers, Cylindrical shells, Shells

A comprehensive theoretical and experimental study is made of free surface sloshing in a vertically oscillating cylindrical container at high frequency with emphasis placed upon the dynamics of the gas-liquid interface. The formation of liquid drops ejected from the free surface, gas entrainment in the liquid, and bubble motions are studied experimentally.

SHELLS

(Also see Nos. 1751, 1777, 1881)

80-1867

Dynamic Stability of Cylindrical Shells Taking into Account In-Plane Inertia and In-Plane Disturbance

K. Shirakawa

College of Engrg., Univ. of Osaka, Prefecture, Sakai, Bull. JSME, 23 (176), pp 163-169 (Feb 1980) 6 figs, 13 refs

Key Words: Shells, Cylindrical shells, Stability, Periodic excitation

This paper is concerned with the dynamic stability of cylindrical shells subjected to periodic axial load or periodic external pressure.

80-1868

Recent Studies on the Correlation Between Vibration and Buckling of Stiffened Cylindrical Shells

J. Singer

Technion, Israel Inst. of Tech., Haifa/Israel, Z. Flugwiss, 3 (6), pp 333-343 (Nov/Dec 1979) 13 figs, 49 refs

Key Words: Shells, Cylindrical shells, Stiffened shells, Correlation techniques

The vibration correlation technique for definition of the boundary conditions of stiffened shells is briefly reviewed. The technique consists essentially of an experimental determination of the natural frequencies, in vibration modes that resemble the buckling modes of a loaded shell, and assessment of the equivalent elastic restraints which represent the boundary conditions by comparison with theoretically predicted frequencies. With these assessed restraints obtained from nondestructive tests, the buckling pressures or loads are calculated. Recent experimental and theoretical studies which strengthen the basis of the method and broaden its applicability are discussed.

80-1869

Dynamic Plastic Buckling of Shells: A Reconsideration of the Vaughan-Florence Analysis

G. Horvay, M.A. Veluswami, and F.D. Stockton

Dept. of Civil Engrg., Univ. of Massachusetts, Amherst, MA, Rept. No. CONF-790802-1, 22 pp (Jan 1979)

N80-13518

Key Words: Shells, Dynamic buckling

Extension of the Vaughan-Florence (VF) analysis to encompass axial variation of the impulse load revealed that the omega to the 2nd power term may not be neglected, because it constitutes only restraint on the motion that is caused by the departure from axial uniformity.

80-1870

Full-Scale and Model Test on Wind-Induced, Static and Dynamic Stresses in Cooling Tower Shells

H.-J. Niemann and J. Ruhwedel

Institut f. Konstruktiven Ingenieurbau, Ruhr-Universität, Bochum, West Germany, Engrg. Struc., 2 (2), pp 81-89 (Apr 1980) 19 figs, 2 tables, 16 refs

Key Words: Shells, Cooling towers, Wind-induced excitation, Experimental data

The response of the shell of concrete cooling towers to turbulent wind is investigated by experimental methods. Calculations based on membrane theory are used to verify the reliability of the test results with respect to the membrane forces. The tests include measurements of wind load and shell response in model and full-scale conditions. For the model tests, dynamic similarity of the model was observed, and the atmospheric boundary layer was simulated. The Schmehausen cooling tower was equipped with special strain and pressure pick-ups for the full-scale observations. The results suggest that there is considerable bending in circumferential stresses, and that dynamic stresses are not always correctly calculated by assuming a static design wind load, affecting in particular the buckling safety of the shell.

80-1871

Studies in Dynamics and the Application of Asymptotic Methods in Solid Mechanics

B.E. Bennett

Ph.D. Thesis, Stanford Univ., 122 pp (1979)

UM 8006289

Key Words: Shells, Transient response, Wave propagation

A sequence of studies is made including transient wave propagation, the application of wave front expansions to transient wave propagation, and the application of the WKBJ method to the static and dynamic analyses of thin elastic shells. For convenience and the purpose of organization, this dissertation is divided into two parts. In the first part the dynamic response of an elastic half space with an overlying acoustic fluid is investigated. It is shown that the response of the solid can be obtained from the solution of the same problem without the fluid. An example is given. In the second part, some further developments are made in the application of the WKBJ method, using an exponential expansion, to the asymptotic analysis of general thin elastic shells.

RINGS

(See Nos. 1839, 1858)

PIPES AND TUBES

(Also see No. 1849)

80-1872

Elastic-Plastic Analyses for Seismic Reserve Capacity in Power Plant Braced Frames

T.A. Nelson and R.C. Murray

Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. UCRL-52614, 89 pp (Oct 1978)

N80-15303

Key Words: Frames, Pipes (tubes), Seismic response

Elastic and elastic-plastic seismic analyses were conducted on a braced steel frame using eight time-history records. In order to ensure operability, a frame model incorporating a piping system was subjected to the above seismic loadings using elastic analyses. It was found that the piping system components controlled the seismic capacity of the combined structure. The average results show a reserve capacity of 2.6 times the seismic design level.

80-1873

Pipeline Response to Random Ground Motion

A. Hindy and M. Novak

Stone and Webster of Canada Ltd., Toronto, Ontario, Canada, ASCE J. Engr. Mech. Div., 106 (2), pp 339-360 (Apr 1980) 15 figs, 24 refs

Key Words: Pipelines, Underground structures, Seismic response, Random response, Continuous parameter method

Seismic response of buried pipelines in both lateral and longitudinal directions is investigated theoretically using a distributed-mass model of the pipe. Soil-pipe interaction is accounted for considering complex soil reactions derived for a viscoelastic continuum. Seismic excitation is considered random and partially correlated. The aim of the study is to find out whether this kind of excitation could produce pipe stresses in excess of those calculated under the usual assumption of full correlation of seismic excitation. It appears that the lack of correlation of the seismic excitation can produce high stresses in the pipe. The level of these stresses depends on the degree of correlation of the excitation and its frequency contents.

DUCTS

(Also see Nos. 1821, 1882)

80-1874

Oscillations of the Supersonic Flow Downstream of an Abrupt Increase in Duct Cross Section

G.E.A. Meier, G. Grabitz, W.M. Jungowski, K.J. Witczak, and J.S. Anderson

Max-Planck-Institut f. Strömungsforschung, Göttingen, W. Germany, AIAA J., 18 (4), pp 394-395 (Apr 1980) 4 figs, 4 refs

Key Words: Ducts, Fluid-induced excitation, Shock wave propagation

The flow in a duct following a sudden change in section is described. Sonic flow through a convergent nozzle expands into a larger cross section to produce a mixed supersonic flow, and a low base pressure in the upstream corners. Under certain pressure conditions, oscillations occur in the duct and excessive externally generated noise results. These self-excited oscillations are caused by a boundary-layer/shock-wave interaction, and can exist in both circular and rectangular ducts. Many types of oscillations have been observed in different test arrangements, and a complete description of the flow may be found in the full paper.

80-1875

Characterization of Acoustic Disturbances in Linearly Sheared Flows

S.P. Koutsoyannis

Dept. of Aeron. and Astron., Stanford Univ., CA, Rept. No. SU-JIAA-TR-12; NASA-CR-162577, 40 pp (July 1978)

N80-15869

Key Words: Ducts, Sound propagation

The equation describing the plane wave propagation, the stability, or the rectangular duct mode characteristics in a compressible inviscid linearly sheared parallel, but otherwise homogeneous flow, is shown to be reducible to Whittaker's equation.

80-1876

Reciprocity Principle in Duct Acoustics

Y.C. Cho

NASA, Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-79300, E-250, 23 pp (1979)

N80-12824

Key Words: Ducts, Acoustic reflection, Acoustic scattering, Reciprocity principle

Various reciprocity relations in the duct acoustics have been derived on the basis of the spatial reciprocity principle implied in Green's functions for linear waves. The derivation includes the reciprocity relations between mode conversion coefficients for reflection and transmission in nonuniform ducts, and the relation between the radiation of a mode from an arbitrarily terminated duct and the absorption of an externally incident plane wave by the duct. Such relations are well defined as long as the systems remain linear, regardless of acoustic properties of duct nonuniformities which cause the mode conversions.

80-1877

Sound Propagation Through Parallel Jets Exhausting from Ducts

L. Ting

Courant Inst. of Mathematical Sciences, New York Univ., New York, NY 10012, J. Acoust. Soc. Amer., 67 (3), pp 782-791 (Mar 1980) 8 figs, 14 refs

Key Words: Ducts, Sound propagation, Acoustic linings

The method of matched asymptotic expansions is employed to construct the solution for the propagation of sound through parallel jets which exit from long ducts and are

surrounded by a uniform parallel stream. Parts of the duct walls are lined with acoustically absorbent material. The small parameter for the expansion is the ratio of the inner jet thickness to the acoustic wavelength. The problem is further simplified when we impose the condition that the speed of the outer stream, which accounts for the forward motion speed of the ducts, is much smaller than the speeds of the jets. This condition is valid during landing and takeoff operations. Farfield pressure distributions are obtained for the case in which the inner jet is much faster than the outer jet and the case in which the two jets are the same.

80-1878

Propagation in Ducts

M. Perulli

Office National d'Etudes et de Recherches Aerospatiales, Paris, France, In AGARD Special Course on Acoustic Wave Propagation, 23 pp (Aug 1979)

N80-14864

(In French)

Key Words: Ducts, Acoustic waves, Wave propagation

The study of acoustic wave propagation in ducts is accomplished by beginning with a wave equation in which the following come into play: duct geometry, the median heights and fluctuations characterizing the fluid, and the acoustic properties of the walls. Generally, this equation can be solved only by complex numerical methods and, to this day, only the particular cases which correspond to simple geometries can be treated analytically. Numerous physical properties are presented and the case is discussed for an infinite duct of any section but constant, in which a uniformly homogeneous fluid flows; the acoustic impedance of the walls can or cannot be absorbent. An expression for the pressure field is given for different duct geometries (rectangular, annular, and cylindrical).

BUILDING COMPONENTS

(Also see Nos. 1853, 1890)

80-1879

Forced Symmetrical Vibration of a Thin Finite Circular Membrane Due to Impulsive Pressure Pulse Uniformly Distributed Along the Circumference of a Concentric Circle

B.C. Bhadra

Dept. of Mathematics, Univ. of Visva-Bharati Santiniketan, India, Rev. Roumaine Sci. Tech., Méc. Appl. 24 (4), pp 609-611 (July /Aug 1979) 1 ref

Key Words: Membranes (structural members), Circular membranes, Forced vibration, Hankel transformation, Laplace transformation

Forced symmetrical vibration of a finite circular membrane produced by transient pressure pulse and uniformly distributed along the circumference of a concentric circle has been investigated by finite Hankel Transform and Laplace Transform techniques.

ELECTRIC COMPONENTS

TRANSFORMERS

80-1880

Feasibility Study of an Active System for Transformer Noise Abatement

D. Yannucci

Medium Power Transformer Div., Westinghouse Electric Corp., Sharon, PA, Rept. No. C00-4376-T1, 53 pp (May 1979)

N80-13378

Key Words: Transformers, Noise generation, Noise reduction, Active control

The feasibility of noise abatement of medium power transformers by means of a novel concept for active sound suppression is presented. Noise abatement was accomplished by destructive interference of sound pressure fluctuations in three narrow frequency bands.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 1755, 1756, 1757, 1802, 1803, 1804, 1806, 1807, 1808, 1809, 1810, 1811, 1816, 1818, 1819, 1820, 1822, 1824, 1880, 1885, 1912, 1913, 1921, 1952, 1962, 1976, 1978, 1979, 1980)

80-1881

Acoustic Radiation Pressure on a Rigid Sphere in a Spherical Wave Field

T. Hasegawa, M. Ochi, and K. Matsuzawa
Faculty of Science, Ehime Univ., Matsuyama, Ehime 790, Japan, J. Acoust. Soc. Amer., 67 (3), pp 770-773 (Mar 1980) 8 figs, 12 refs

Key Words: Spheres, Sound pressures

An analysis of the acoustic radiation pressure acting on a rigid sphere in a spherical sound field is described.

80-1882

Band-Limited Power Flow into Enclosures. II

L.D. Pope and J.F. Wilby
Bolt, Beranek and Newman, Inc., Canoga Park, CA 91303, J. Acoust. Soc. Amer., 67 (3), pp 823-826 (Mar 1980) 1 ref

Key Words: Enclosures, Elastic waves, Sound waves

This paper presents an expression for calculating power flow to nonresonant acoustic modes of the enclosure (modes resonant above and below the frequency band of interest) from structural modes resonant below, within, and above the band. If no resonant acoustic modes exist in a band, the new results can be used to predict the power inflow. If resonant acoustic modes do exist, the results can be used to increase the precision of the power inflow calculation. The procedure to be used in the calculation of the sound level in the enclosed space is presented.

80-1883

Diffraction of Lamb Waves by a Finite Crack in an Elastic Layer

S. Rokhlin
Dept. of Materials Engrg., Ben-Gurion Univ. of the Negev, Beer-Sheva, Israel, J. Acoust. Soc. Amer., 67 (4), pp 1157-1165 (Apr 1980) 3 figs, 24 refs

Key Words: Cracked media, Elastic waves, Wave diffraction

This paper analyzes the diffraction of Lamb waves by a finite crack situated on the plane of symmetry of an elastic layer. The surface of the crack and of the layer are assumed to be stress-free. The problem is solved by the modified Wiener-Hopf technique. The field of the reflected and transmitted waves, and also the field in the vicinity of the crack, are given as an expansion in natural waves of the elastic layer. The amplitudes of these waves are expressed in terms of certain generalized quantities, which are found from exponentially converging infinite systems of equations.

80-1884

Flow-Induced Tones in Side-Branch Pipe Resonators

M.L. Pollack
General Electric Co., P.O. Box 1072, Schenectady, NY 12301, J. Acoust. Soc. Amer., 67 (4), pp 1153-1156 (Apr 1980) 8 figs, 9 refs

Key Words: Acoustic resonators, Fluid-induced excitation, Fast Fourier transform

Acoustic tones generated by turbulent flows and shear-layer-instability interactions with side-branch resonator pipes were investigated experimentally using fast Fourier transform techniques. The experimental values of resonant frequencies and instability frequencies were compared with predictions for two stages of shear-layer interaction. Relative tonal amplitudes are shown to demonstrate cut-in and cut-out phenomena. The qualitative differences between turbulent-flow-generated tones and instability-generated tones are also noted.

SHOCK EXCITATION

(Also see No.s 1765, 1766, 1767, 1768, 1769, 1771, 1783, 1798, 1799, 1831, 1853, 1854, 1859, 1872, 1874, 1905, 1907, 1908, 1920, 1953, 1961, 1968)

80-1885

Measurement of Cavitation Shock around Two-Dimensional Elliptic Cylinders

T. Yokomizo and M. Yamamasu
Dept. of Mech. Engrg., Kanto-Gakuin Univ., Yokohama, Japan, Bull. JSME, 23 (176), pp 201-209 (Feb 1980) 20 figs, 4 refs

Key Words: Cavitation noise, Noise measurement

The intensity of cavitation shock-noise is measured by using eight models of elliptical cylinders of various eccentricities for the purpose of knowing the effect of a change of the shape of a body in a cavitating flow. The periods of cavitation shock are also measured.

80-1886

Behavior of Slopes in Weakly Cemented Soils under Static and Dynamic Loading

N. Sitar

Ph.D. Thesis, Stanford Univ., 183 pp (1979)
UM 8006355

Key Words: Seismic response, Soils

An investigation of slope behavior in cemented soils is presented aimed at documenting the behavior of natural slopes in weakly cemented soils, defining the engineering response of weakly cemented soils under static and dynamic loading, establishing the stress conditions in steep slopes during static and dynamic loading, and developing guidelines for evaluation of seismic stability of slopes in cemented soils. To achieve these objectives, field observations, a laboratory testing program, and static and dynamic finite element analyses of idealized vertical slopes in linear elastic material were performed.

VIBRATION EXCITATION

(Also see Nos. 1797, 1898, 1950)

80-1887

Free and Steady State Vibration of Non-Linear Structures Using a Finite Element-Non-Linear Eigenvalue Technique

L.C. Wellford, Jr., G.M. Dib, and W. Mindle

Civil Engr. Dept., Univ. of Southern California, Los Angeles, CA, Intl. J. Earthquake Engr. Struc. Dynam., 8 (2), pp 97-115 (Mar/Apr 1980) 17 figs, 9 refs

Key Words: Periodic response, Free vibration, Nonlinear systems, Finite element technique, Eigenvalue problems, Plates, Circular plates

The problem of free vibration of non-linear structures is considered. Variational principles for non-linear eigenvalue problems are defined and implemented with finite element models to define numerical approximations for the free vibration problem. To demonstrate the proposed techniques the free vibration and steady state vibration characteristics of a geometrically non-linear circular plate are determined.

80-1888

Cross Spectral Densities in Random Vibration Analysis

J.D. Robson

Rankine Professor of Mech. Engrg., Univ. of Glasgow, UK, Intl. J. Vehicle Des., 1 (2), pp 121-129 (Feb 1980) 5 figs, 6 refs

Key Words: Random vibration, Spectral energy distribution techniques, Signal processing techniques

The relevance of multi-variate random processes in random-vibration problems is considered. The ideas of cross spectral density and coherence are introduced and the relevance of matrix formulation is emphasized. The limited nature of analogy with the problem of harmonic response is also emphasized, but the value of the analogy is demonstrated. The consequences of complete coherence are discussed, some aspects of response formulation in terms of normal co-ordinates are explored and the concept of partial coherence is explained.

80-1889

The Effect of Analysis Bandwidth on the Accuracy of Measurements and Predictions of Single Degree of Freedom System Behavior

A.W. Walker

Admiralty Marine Technology Establishment, Teddington, UK, Rept. No. AMTE(N)-TM-79401; BR67-702, 25 pp (Mar 1979)
N80-13526

Key Words: Single degree of freedom systems, Frequency response method, Error analysis

The accuracy of measurements or predictions of the frequency response of a single degree of freedom system depends on the frequency resolution of the analysis technique. If the ratio of analysis bandwidth to the 3 dB bandwidth of the resonance is too great, negative bias errors occur at resonance in estimates of both power spectral levels and transfer function amplitudes. These errors, which were calculated numerically, are presented and compared with appropriate experimental data.

80-1890

Regulating Calculation of Random Parameters in Structural Mechanics (Part II, The Case to be Restricted by the Standard Deviations of Natural Frequencies)

K. Tanaka and H. Onishi

Mech. Engrg. Research Lab., Hitachi, Ltd., Tsuchiura, Japan, Bull. JSME, 23 (176), pp 260-264 (Feb 1980) 6 figs, 6 tables, 4 refs

Key Words: Variable material properties, Natural frequencies, Structural members

A method of regulating the allowable deviations of the random parameters of structural elements is investigated, when the allowable deviations of the eigenvalues are given. Linear deviation analysis by the partial derivative method is presented, and its applicability and characteristics are examined.

80-1891

The Mean-Value Method of Predicting the Dynamic Response of Complex Vibrators

E. Skudrzyk

State College, Pennsylvania State Univ., PA 16801, J. Acoust. Soc. Amer., 67 (4), pp 1105-1135 (Apr 1980) 22 figs, 3 tables, 49 refs

Key Words: Vibrators (machinery), Frequency response method, Mechanical admittance

The mean-value theory predicts the mean line through the logarithmically recorded frequency-response curve of a complex vibrator, the height of the resonance peaks, and the height of the minima that occur between every two resonance peaks. It predicts the mean and the extremes in the frequency-response curve from the first resonance of the vibrator to very high frequencies. The computations are based on the mode masses and on the density of the resonances.

80-1892

A Simplified Approach to the Theoretical Formulation for the Vibrations of a Cavity-Backed Panel (Une Approache Simplifiée Aux Formulations Théoriques Pour Les Vibrations d'un Panneau Adossé à une Cavité)

R.W. Guy and S.G. Matter

Centre des Études Sur le Bâtiment, Université Concordia, Montréal, Québec, Canada, Acustica, 44 (1), pp 35-40 (Jan 1980) 3 figs, 8 refs

(In French)

Key Words: Panel-cavity response, Sound transmission

A re-evaluation has been made of a cavity-backed panel analysis, an understanding of the sound transmission in air under real finite conditions being based on a study of this model. A simplied approach is derived and demonstrates clearly the analytical techniques used and allows the rapid development of a formulations. This work should simplify the development of further models and also facilitate the teaching of the concept to students.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 1753, 1949)

80-1893

The Stabilization of a North-Seeking Platform Using a Dynamically Tuned Hooke's Joint Gyroscope

J.S. Burdess and C.H.J. Fox

Dept. of Mech. Engrg., Newcastle Univ., Newcastle upon Tyne, UK NE1 7RU, J. Appl. Mech., Trans. ASME, 47 (1), pp 167-171 (Mar 1980) 5 figs, 8 refs

Key Words: Universal joints, Gyroscopes, Dynamically tuned structures, Tuned dampers, Damping effects, Unbalanced mass response, Alignment

The paper shows that the ideally tuned Hooke's joint gyroscope is capable of operating as a gyrocompass. The dynamic response of the compass is examined in detail and its accuracy as a north-seeking device is assessed. The need for precision tuning is eliminated by supporting the gyroscope on a single-degree-of-freedom platform driven via feedback of the gyrorotor displacement in azimuth making the response of the combined system essentially that of the ideal gyroscope. The overall system is insensitive to mistuning errors and will automatically align the gyrospin axis with true north irrespective of any initial offset. The effects of damping, mass unbalance, and platform misalignment are assessed.

80-1894

The Dynamical Characteristics of a Gyroscope with a Tuned Elastic Suspension

C.H.J. Fox and J.S. Burdess

Dept. of Mech. Engrg., Univ. of Newcastle upon Tyne, Newcastle upon Tyne, NE1 7RU, UK, J. Appl. Mech., Trans. ASME, 47 (1), pp 161-166 (Mar 1980) 6 figs, 7 refs

Key Words: Gyroscopes, Dynamically tuned structures, Elastic foundations, Tuned dampers

This study investigates the dynamics of a gyroscope rotor, supported on a "heavy" elastic suspension, using a mathematical model which allows the gyroscope to be treated as a two-degree-of-freedom rigid body on a light suspension. The natural frequencies are functions of spin rate and it is shown

that the lower natural frequency can be reduced to zero by appropriate selection of suspension parameters. In this condition the gyroscope is "tuned" and could provide a useful inertial reference. Some problems associated with predicting the tuning speed of a practical gyroscope are highlighted.

80-1895

Analyses and Tests of the B-1 Aircraft Structural Mode Control System

J.H. Wykes, T.R. Byar, C.J. MacMiller, and D.C. Greek

Rockwell Intl. Corp., El Segundo, CA, Rept. No. H-1109; NA-79-405; NASA-CR-144887, 268 pp (Jan 1980)

N80-15073

Key Words: Dampers, Vibration damping, Aircraft

Analyses and flight tests of the B-1 structural mode control system (SMCS) are presented. Improvements in the total dynamic response of a flexible aircraft and the benefits to ride qualities, handling qualities, crew efficiency, and reduced dynamic loads on the primary structures, were investigated. The effectiveness and the performance of the SMCS, which uses small aerodynamic surfaces at the vehicle nose to provide damping to the structural modes, were evaluated.

80-1896

Viscoelastic Polymer for Printed-Circuit-Board Vibration Damping

M.R. Probst

Harry Diamond Labs., Adelphi, MD, Rept. No. HDL-TM-79-22, 14 pp (Sept 1979)

AD-A077 303/5

Key Words: Viscoelastic damping, Circuit boards, Vibration tests, Plates

A viscoelastic polymer was selected as a possible means of vibration damping for electronic printed-circuit-board (PCB) assemblies *in a surface-to-air guided-missile application.* Thin layers of the self-adhesive polymer were bonded to dummy and real PCB assemblies, and accelerations were recorded at various PCB locations during sinusoidal vibration tests.

80-1897

On the Suppression of Self-Excited Vibration by Servodamper

N. Tanaka, M. Miyashita, N. Suzuki, Y. Iwata, and A. Kanai

Mech. Engrg. Lab. 5-12-2 Fujimi-cho Higashimurayama-shi, Tokyo, Japan, Bull. JSME, 23 (176), pp 265-272 (Feb 1980) 19 figs, 11 refs

Key Words: Dampers, Vibration control, Chatter, Machine tools

A technique to suppress the self-excited chatter vibration in machine tools by a servodamper, designed by means of the output feedback control theory, is described. The effectiveness of the servodamper for eliminating the chatter under various cutting conditions is illustrated by experiment.

80-1898

On the Houde Damper for a Damped Vibration System

T. Ioi and K. Ikeda

Chiba Inst. of Tech., Narashino, Japan, Bull. JSME, 23 (176), pp 273-279 (Feb 1980) 9 figs, 6 refs

Key Words: Dampers, Forced vibration, Free vibration

Vibration prevention in systems with positive and negative damping by means of Houde dampers is investigated. The optimum damping factor of the Houde damper and the corresponding maximum amplitude of the main vibration system is determined; for self-excited systems, i.e. with negative damping, the optimum damping factor of the Houde damper and a critical value of the negative damping factor of the system is obtained.

FATIGUE

(Also see Nos. 1779, 1780, 1781, 1782, 1785, 1828, 1835, 1928)

80-1899

Design Against Fatigue – Current Trends

W.T. Kirkby, P.J.E. Forsyth, and R.D.J. Maxwell

Royal Aircraft Establishment, Farnborough, UK, Aeronaut. J., 84 (829), pp 1-12 (Jan 1980) 18 figs, 6 refs

Key Words: Fatigue life, Aircraft, Design techniques

The role of fatigue in the design, testing and operation of aircraft is described. The application of aluminum alloys, titanium, and composites is discussed.

80-1900

The Effect of Load Stepdown on Fatigue Crack Arrest and Retardation

H. Sehitoglu and D.L. McDiarmid

Dept. of Mech. Engrg., City University Northampton Square, London EC1V OHB, UK, Intl. J. Fatigue, 2 (2), pp 55-60 (Apr 1980) 10 figs, 1 table, 31 refs

Key Words: Fatigue life, Crack propagation, Steel

The effect of a decrease in stress range on fatigue crack propagation behavior in mild steel plate is investigated. The delay period between the arrest of a Stage II crack and its re-propagation is found to be a function of load stepdown ratio and specimen thickness. The length over which crack retardation is observed is related to the platic zone size associated with the initial high stress level. Non-propagating cracks occur when the ratio of the stepdown stress intensity range is approximately 0.6 times the initial stress intensity range, for the thicknesses tested.

80-1901

Asymptotic Stress Intensity Factors for Fatigue Crack-Growth Calculations

D.P. Rooke

Materials Dept., Royal Aircraft Establishment, Farnborough, Hants, GU1 46TD, UK, Intl. J. Fatigue, 2 (2), pp 69-75 (Apr 1980) 11 figs, 9 refs

Key Words: Fatigue life, Crack propagation

A simple procedure is proposed for calculating stress intensity factors for cracks at stress concentrations. The procedure is based on the known limiting values for both short and long cracks. The errors introduced, by the approximate analysis, into calculations of growth times in fatigue are evaluated and shown to be comparable to, or less than, those due to other sources such as uncertainties in crack length, service loads and material properties. The simple analysis is shown, in particular, to be conservative for the technologically important region of short cracks at stress concentrations.

80-1902

Cyclic and Monotonic Crack Propagation in a High Toughness Aluminium Alloy

D. Rhodes, J.C. Radon, and L.E. Culver

Dept. of Mech. Engrg., Imperial College, Exhibition Road, London SW7 2BX, UK, Intl. J. Fatigue, 2 (2), pp 61-67 (Apr 1980) 8 figs, 3 tables, 14 refs

Key Words: Fatigue life, Crack propagation

An extension of the R-curve concept is used to derive expressions to account for stress ratio effects in fatigue crack propagation, and to predict unstable crack growth. These conditions are related to the 'engineering stress intensity factor', which is based on the remote load or stress, and the crack length measured prior to loading. Early results from a continuing test program, using DTD.5120 (7010-T7651) aluminium alloy, are presented.

ELASTICITY AND PLASTICITY

80-1903

Wave Propagation in Viscoelastic Media

R.C.Y. Chin

Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. UCRL-83019, 61 pp (July 1979)

N80-15378

Key Words: Viscoelastic media, Wave propagation

The mathematical formulations of the wave propagation problem in a linear viscoelastic solid are reviewed from the point of view of constitutive equations and the theory of linear physical systems. Various general results from the theory of propagating singular surfaces and from the mathematical theory of hyperbolic equations are applied to the analysis of the wave propagation process. The impulse response of three viscoelastic media are analyzed by use of asymptotic methods. The three material models are the standard linear solid, the standard linear solid with a continuous spectrum of relaxation times, and the power law solid.

80-1904

Harmonic Waves in a Linear Viscoelastic Plate

K. Tanaka and A. Kon-No

Faculty of Engrg., Kyoto Univ., Kyoto, Japan, Bull. JSME, 23 (176), pp 185-193 (Apr 1980) 8 figs, 2 tables, 16 refs

Key Words: Harmonic waves, Wave propagation, Plates, Viscoelastic media, Wave guide analysis

The procedure of analysis of harmonic waves which propagate in elastic wave guides is applied to harmonic waves in linear viscoelastic wave guides. The formal solutions which satisfy the frequency equations of guided wave motions in a linear viscoelastic plate are thus obtained. The frequency spectra of guided waves in a viscoelastic plate are compared with those of elastic waves, and their differences are discussed.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 1776, 1785, 1929, 1972)

80-1905

Ytterbium Piezoresistance Gage for Measurement of Air Shocks to 2 GPa

D.D. Keough, P.S. DeCarli, and L.B. Hall

333 Ravenswood Ave., Menlo Park, CA 94025, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 659-666, 10 figs, 12 refs (Avail: see 80-1972)

Key Words: Transducers, Shock tests, Test equipment and instrumentation

The piezoresistance response of ytterbium and the mechanical simplicity of two steel plattens have been combined to produce a fast response transducer which has recorded successfully in a variety of extreme air and ground shock environments. The gage is intended for the measurement of transient wall pressure or in-situ transient stresses. In both cases the ytterbium is maintained in essentially uniaxial strain by the packaging configuration.

80-1906

Backface Surface Acoustic Measurements of Boundary Layer Noise

V.D. Peckham, R.T. Winnicki, J.L. Forkois, and P.J. Legendre

Kaman Sciences Corp., P.O. Box 7463, Colorado Springs, CO 80933, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 229-238, 11 figs, 1 table, 5 refs (Avail: see 80-1972)

Key Words: Acoustic detection, Transducers, Test equipment and instrumentation

A wind tunnel test was conducted on a ballistic re-entry vehicle model in which two types of backface acoustic sensors are compared to a Gardon gage boundary layer transition transducer.

80-1907

Design and Application of a 10 KBAR Blast Pressure Transducer

E.L. Cole and J.C. Schneider

Kaman Sciences Corp., Colorado Springs, CO 80933, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 653-658, 3 figs, 15 refs (Avail: 80-1972)

Key Words: Transducers, Shock tests, Shock tube tests, Test equipment and instrumentation

The design of a pressure transducer and its application to the direct measurement of blast overpressures in a nuclear-driven shock tube is described. The transducer features a diaphragm whose deflection is sensed using eddy-currents. Designs of both the transducer and probe are presented with some of the problems and solutions related to installation of a sensor in this dynamic and severe environment.

80-1908

Modified Bar Gauges for Use in Severe Airblast Measurements

P.L. Coleman

Systems, Science and Software, P.O. Box 1620, La Jolla, CA 92038, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 645-652, 9 figs, 6 refs (Avail: see 80-1972)

Key Words: Test equipment and instrumentation, Shock tests

A bar gauge, which is essentially an instrumented Hopkinson bar, allows a "delicate" sensor such as a quartz crystal or ytterbium piezoresistive grid to make measurements in a severe blast environment. Several modifications of a bar gauge to measure pressures in strong air shocks are described. Examples are given for pressures up to at least 2 gigapascal (20 kilobar).

80-1909

Spectral Measurement of Angular Vibration

D.A. Kienholz

Anamet Laboratories, Inc., San Carlos, CA, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 157-163, 6 figs, 2 tables, 5 refs (Avail: see 80-1972)

Key Words: Vibration measurement, Measurement techniques, Spectrum analysis

A method for measuring very small rotations at frequencies as high as 1 kHz in airborn laser and optical systems is described.

80-1910

Theory of the Vibrating Capacitor for Displacement Measurement

B.L. Wedzicha and R.E. Miles

Procter Dept. of Food Science, Univ. of Leeds, Leeds LS2 9JT, UK, J. Phys. E. (Sci. Instr.), 13, pp 406-408 (Apr 1980) 3 figs, 1 table, 3 refs

Key Words: Measuring instruments

The equation of state for the vibrating capacitor has been solved for the case of a decaying vibration.

80-1911

Use of High Strain Dynamic Viscoelastometer in the Analysis of Tire Rolling Resistance

Y.D. Kwon and D.C. Prevorsek

Allied Chemical Corp., Morristown, NJ, SAE Paper No. 800242, 12 pp, 5 figs, 4 tables, 7 refs

Key Words: Measuring instruments, Tires, Automobile tires, Rolling friction

The use of high strain dynamic viscoelastometer for screening of materials in the manufacture of tires is described. Tests are made on a specimen either taken from a tire, or a laboratory molded experimental sample, and the comparative rolling resistance of the tire comprising the sample is analyzed.

80-1912

Exposure Considerations for Impulse and Continuous Noise

G.L. Cluff

Arizona State Univ., Tempe, AZ, S/V Sound Vib., 14 (3), pp 26-28 (Mar 1980) 1 fig, 12 refs

Key Words: Noise measurement, Measurement techniques

A method for detecting and measuring impulse noise embedded in continuous noise is discussed and a procedure for combining the dose from each type of noise is developed.

80-1913

The Measurement of Structure-Borne Sound Sensitivity by Means of Impulse Excitation (Untersuchung zur Anwendbarkeit Impulsformiger Anregung f. ein Messverfahren zur Bestimmung von Korperschallanregung und -Übertragung)

K.-J. Buhlert

Institut f. Technische Akustik der Technischen Universitat Berlin, Einsteinufer 27, D-1000 Berlin 10, Deutschland, Appl. Acoust., 13 (1), pp 69-82 (Jan/Feb 1980) 10 figs, 4 refs

(In German)

Key Words: Structure borne noise, Buildings, Testing techniques, Measurement techniques

A procedure has been developed for measuring the structure-borne sound sensitivity of building structures to stationary excitation. This procedure can be conducted with simple sound pressure and vibration measurements. The precision and reproducibility of the measurement procedure were tested. In order to determine the structure-born sound sensi-

tivity and the vibratory point forces to transient excitation, impulses were tested and compared with the results obtained with stationary excitation.

thermore, the DAS provides the capability for on-line monitoring and control of a wide variety of analog instrumentation.

80-1914

Wind Tunnel Model Deflection System

R.F. Jarvis
Grumman Aerospace Corp., Bethpage, NY 11714, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 263-271, 9 figs (Avail: see 80-1972)

Key Words: Wind tunnel tests, Dynamic tests, Measuring instruments

A system for measurement of deformation of a wind tunnel model was developed which is simple, economical and capable of producing accurate deflection data both statically and dynamically. The system uses a series of strain gage beams which are installed in the model and provide a means of measuring the slope at discrete points as the model undergoes deformations. The curve generated from these data is then integrated to produce the model deflection curve. The design, fabrication, installation, calibration and testing of this model deformation system is described.

80-1915

Real-Time Data Acquisition System for the NASA Langley Transonic Dynamics Tunnel

P.H. Cole
NASA Langley Res. Ctr., Hampton, VA 23665, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 273-286, 15 figs, 2 refs (Avail: see 80-1972)

Key Words: Data processing, Wind tunnel tests

A computer-controlled tunnel Data Acquisition System (DAS) is described which is specifically tailored to acquire large amounts of dynamic data over a wide frequency range and to provide real-time, interactive data reduction, analysis, and display, required in aeroelastic research and testing. Fur-

80-1916

Processing Noise and Vibration Data for Gas Turbine Engine Development

R.E. Harper
Pratt & Whitney Aircraft Group, Commercial Products Div., United Technologies Corp., East Hartford, CT, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 179-183, 5 figs, 1 table (Avail: see 80-1972)

Key Words: Gas turbine engines, Data processing

Three data processing procedures are described for use in the development of gas turbine engines. The procedures provide a means of increasing the spectral resolution of a Fourier-type analyzer through intentional aliasing of the digitized data; a method of extracting phase information from unsteady signals; and a statistical description of the unsteadiness of acoustic signals using a variant of the amplitude histogram.

80-1917

Modal Testing with Asher's Method Using a Fourier Analyzer and Curve Fitting

R.R. Gold and W.L. Hallauer, Jr.
Dept. of Aerospace and Ocean Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 185-192, 4 figs, 4 tables, 13 refs (Avail: see 80-1972)

Key Words: Testing techniques, Modal tests, Fourier analysis, Curve fitting

An unusual application of the method proposed by Asher for structural dynamic modal testing is discussed. Asher's method has the capability, using the admittance matrix and multiple-shaker sinusoidal excitation, of separating structural modes having indefinitely close natural frequencies. The

present application uses Asher's method in conjunction with a modern Fourier analyzer system but eliminates the necessity of exciting the test structure simultaneously with several shakers. Evaluation of this approach with numerically simulated data demonstrated its effectiveness; the parameters of two modes having almost identical natural frequencies were accurately identified. Laboratory evaluation of this approach was inconclusive because of poor experimental input data.

80-1918

The Use of Minicomputers for Control and Data Handling in Dynamic Tests

R.S. Mills and H. Krawinkler

Dept. of Civil Engrg., Stanford Univ., Stanford, CA 94305, *Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA,* Instrument Society of America: 1979, pp 537-544, 6 figs, 1 table, 6 refs (Avail: see 80-1972)

Key Words: Dynamic tests, Computer-aided techniques

Digital-to-analog and analog-to-digital conversion capabilities of minicomputers as well as their storage requirements, including peripheral storage devices are discussed.

80-1919

Mini-Computer Usage in an Automotive Noise and Vibration Laboratory

R.G. Bowersock, S.M. Akers, and S.P. Mallick

Safety Laboratories Dept., Ford Motor Co., *Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA,* Instrument Society of America: 1979, pp 1-10, 6 figs, 2 tables, 4 refs (Avail: see 80-1972)

Key Words: Measurement techniques, Measuring instruments, Testing techniques, Computer-aided techniques, Automobiles

The role of minicomputer based data acquisition and analysis systems in detecting potential noise and vibration problems encountered during the vehicle design cycle is outlined. Testing methods used on chassis dynamometers, hydraulic ride simulators, and artificial exciters are discussed. Typical applications, including the use of three-dimensional moving graphical displays, are also presented.

80-1920

A Minicomputer Based Vibration Test and Analysis System

R.B. Spencer and P. Ibanez

ANCO Engineers, Inc., 1701 Colorado Ave., Santa Monica, CA 90404, *Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA,* Instrument Society of America: 1979, pp 545-552, 7 figs, 11 refs (Avail: see 80-1920)

Key Words: Test equipment and instrumentation, Seismic response, Computer-aided techniques

An advanced Computerized Vibration Test and Analysis System for seismic qualification testing, based on a commercially available minicomputer, is presented. The basic computer hardware system and the major elements and features of the software for the minicomputer based vibration test and analysis system are described.

80-1921

Pattern Recognition Methods for Acoustic Emission Analysis

P.G. Doctor, T.P. Harrington, and P.H. Hutton

Battelle Pacific Northwest Labs., Richland, WA, Rept. No. NUREG-CR-0910, 58 pp (July 1979) N80-13883

Key Words: Acoustic emission, Pattern recognition techniques, Data processing

Three pattern recognition techniques for acoustic emissions are discussed. They are interfeature correlations, cluster analysis, and multidimensional display techniques. The data acquisition system is described and the types of acoustic emissions are identified.

DYNAMIC TESTS

(Also see No. 1919)

80-1922

Multiple Shaker Production Testing - Part 2

A.C. Keller and E.A. Andress

Spectral Dynamics, Scientific-Atlanta Subidiary, *Noise Vib. Control*, 11 (2), pp 60-63 (Feb 1980) 4 figs

Key Words: Vibration tests, Test equipment and instrumentation

The salient points in the design of a digitally controlled random vibration testing system are reviewed.

80-1923

A Seismic Shake Table for Testing Overhead Equipment

P. Ibanez, W.E. Gundy, and R.S. Keowen

ANCO Engineers, Inc., Santa Monica, CA 90404, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 149-156, 7 figs, 2 refs (Avail: see 80-1972)

Key Words: Test facilities, Shakers, Equipment response, Seismic response, Computer aided techniques

A shake table has been designed specifically for testing of large pieces of overhead mounted equipment such as cable tray and conduit raceways, HVAC ducting, piping, false ceilings, and lighting. Specimens filling a volume 40 ft long x 15 ft wide x 15 ft deep and weighing up to six tons can be accommodated. Input motions of ±3.0 in., ±30 in./sec, and ±2 g are possible. Control and measurement instrumentation, including a computerized vibration analysis system, are described. Typical results are presented.

80-1924

LOX/GOX Mechanical Impact Tester Assessment

J.W. Bransford, C.J. Bryan, G.W. Frye, and S.L. Sichler

John F. Kennedy Space Center, NASA, Cocoa Beach, FL, Rept. No. NASA-TM-74106, 103 pp (Feb 1980) N80-15179

Key Words: Test facilities, Impact tests

The performances of three existing high pressure oxygen mechanical impact test systems were tested at two different test sites. The systems from one test site were fabricated from the same design drawing, whereas the system tested at the other site was of different design. Energy delivered to the test sample for each test system was evaluated and compared. Results were compared to the reaction rates obtained.

80-1925

Digital Instrumentation in a Blast Environment

K.R. Sites

Instrumentation Div. Mgr., Science Applications, Inc., 3351 S. Highland Dr., Suite 206, Las Vegas, NV 89109, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 793-796, 2 figs, 2 refs (Avail: see 80-1972)

Key Words: Test equipment and instrumentation, Blast response, Shock wave propagation, Mines (excavations), Computer-aided techniques

A digital instrumentation package for recording air blast propagation and debris time of arrival data in a non-nuclear blast environment was tested. Potential applications of the TOA Multiplexer are blast wave propagation studies in mines and blast wave measurements in disposable shock tubes.

80-1926

A Dynamic Analysis of Modified Compact-tension Specimens Using Homalite-100 and Polycarbonate Plates

A.S. Kobayashi, K. Seo, J.Y. Jou, and Y. Urabe

Dept. of Mech. Engrg., Univ. of Washington, Seattle, WA 98195, Explt. Mech., 20 (3), pp 73-79 (Mar 1980) 13 figs, 26 refs

Key Words: Testing techniques, Photoelastic analysis, Finite element techniques, Fracture properties, Crack propagation

Dynamic photoelasticity, dynamic finite-element analysis and streaking photography are used to study the dynamic fracture and crack-arrest-responses of a modified compact-tension specimen machined from Homalite-100 and polycarbonate sheets.

80-1927

Experimental Facility to Produce and Measure Compression and Shear Waves in Impacted Solids

Y.M. Gupta, D.D. Keough, D.F. Walter, K.C. Dao, D. Henley, and A. Urweider

Poulder Lab., SRI International, Menlo Park, CA, 94025, Rev. Scientific Instr., 51 (2), pp 183-194 (Feb 1980) 14 figs, 32 refs

Key Words: Test facilities, Shock wave propagation, Dynamic tests

An impact facility has been designed and constructed to produce and measure large amplitude one-dimensional compression and shear waves in solids. Design considerations and experimental details to produce the necessary impact configuration and to measure the particle velocity profiles resulting from compression and shear waves are described. Experimental results show that the impact facility was satisfactorily constructed. After a brief discussion of shear wave measurements, the experimental measurements made under compression and shear loading in polymethyl methacrylate and polycrystalline aluminum oxide are presented.

80-1928

Fatigue Research at Portsmouth Polytechnic

T.V. Duggan

Dept. of Mech. Engrg. and Naval Architecture, Portsmouth Polytechnic, Anglesea Building, Anglesea Road, Portsmouth PO1 3DJ, UK, Intl. J. Fatigue, 2 (2), pp 51-54 (Apr 1980) 15 refs

Key Words; Fatigue tests, Test facilities

The Mechanical Behaviour of Materials Laboratory at Portsmouth Polytechnic is described. It is concerned with all aspects of materials testing; the development of experimental methods and analytical procedures; the integrity assessment of in-service components; the development of mathematical models; and the prediction of component behavior.

SCALING AND MODELING

80-1929

Scale Modeling of Finite Length Fluid Annular Gaps for Flow-Induced Vibration Testing

T.M. Mulcahy and A.J. Miskevics

Components Tech. Div., Argonne National Lab., Argonne, IL, Rept. No. ANL-CT-79-40, 30 pp (June 1979)

N80-15436

Key Words: Vibration tests, Scaling, Fluid induced excitation, Rods

Possible scale model distortions for structural vibration testing are discussed. Conditions for which fluid energy dissipation is expected to be larger in a reduced scale model than in the prototype are defined. This unconservative and sometimes undesirable distortion is confirmed by testing of a vibrating rod surrounded by a finite length fluid filled annulus. A theory for estimating the magnitude of the distortion is presented.

DIAGNOSTICS

80-1930

Development of a Vibration Probe to Inspect Tube Bundle Exchangers

T. Scharton, C. Kidd, and D. Barrett

ANCO Engineers, Inc., Santa Monica, CA, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 139-144, 6 figs (Avail: see 80-1972)

Key Words: Diagnostic techniques, Vibration probes, Heat exchangers, Nuclear reactor components

A number of nuclear power plant steam generators have been troubled with corrosion buildup between the tubes and supporting plates. A vibration type probe which traverses the interior of the tubes during plant shutdown has been developed to inspect the tube and support crevices. The probe incorporates a miniature electric vibrator and accelerometers to induce and measure tube motion at the support plate junctions.

80-1931

Multi-Parameter Analysis for Acoustic Emission Source Identification

L.J. Graham

Science Ctr., Rockwell International, Thousand Oaks, CA 91360, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 53-58, 5 figs, 9 refs (Avail: see 80-1972)

Key Words: Acoustic emission, Vibration analyzers, Diagnostic techniques, Computer-aided techniques, Noise source identification

An acoustic emission multi-parameter analyzer system has been constructed which simultaneously measures several features of each acoustic emission event as it occurs at a maximum average event rate of 1000 events/sec. The features selected for measurement include information on the shape, magnitude and frequency content, and the time, load level and linear position on the specimen at which it occurred. The usefulness of the system in reducing the amount of work, making the results more quantitative, and gaining new insights into the statistical nature of the AE generation process is demonstrated by the analysis of AE from graphite-epoxy composite test specimens.

80-1932

Automated Machinery Diagnostics

J.L. Frarey

Shaker Res. Corp., Northway 10, Executive Park, Ballston Lake, NY 12019, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 763-768, 6 figs, 3 tables, 4 refs (Avail: see 80-1972)

Key Words: Diagnostic techniques

An automated system for monitoring a large number of machines is described. It automatically analyzes and compares spectra, flagging only those signals which have shown significant changes from the last analysis. It assigns a probable cause for the signal variation noted and assesses the seriousness of the problem. In cases where automatic assessment of cause and seriousness is not possible, the system efficiently presents the diagnostic engineer with the significant data.

80-1933

Measuring Unsteady Pressure on Rotating Compressor Blades

D.R. Englund, H.P. Grant, and G.A. Lanati

Lewis Res. Ctr., NASA, Cleveland, OH, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 413-426, 8 figs, 8 tables, 7 refs (Avail: see 80-1972)

Key Words: Diagnostic techniques, Compressor blades, Blades

In the search for new diagnostic techniques the measurement of unsteady pressure on rotating compressor blades under gas turbine engine operating conditions was investigated.

80-1934

Maintenance Troubleshooting with Ultrasonic Equipment

M.A. Goodman

UE Systems, Inc., New York, NY, Plant Engr., 34 (7), pp 103-106 (Apr 3, 1980) 2 tables

Key Words: Diagnostic instrumentation, Ultrasonic techniques

The use of ultrasonic equipment for detecting steam and air leaks through faulty values, malfunctioning steam traps, or poorly designed systems is described. Early detection of other malfunctions, such as bearing failure, gear problems and internal hydraulic leaks is also discussed.

80-1935

Development of a Non-Invasive Acoustic Leak Detection System for Large High Pressure Gas Valves

W.J. Shack, W.A. Ellingson, and C.A. Youngdahl

Argonne National Lab., 9700 S. Cass Ave., Argonne, IL 60439, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 2, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 391-399, 9 figs, 10 refs (Avail: see 80-1972)

Key Words: Acoustic emission, Diagnostic techniques, Valves

An on-line system for the detection of leaks in high pressure valves used in the cool conversion industry was developed. The diagnostic system is based on the detection and characterization of acoustic emissions generated in a valve by turbulent flow exiting from a leakage.

80-1936

Acoustic Emission Sensors Locate Leaks

Des. News, 36 (7), pp 130-131 (Apr 1980)

Key Words: Diagnostic techniques, Acoustic emission

Acoustic emission leak locators can be employed for remote leak detection of such normally inaccessible components as

buried pipelines and hot vessels, even in noisy factory-type environment. The total noise registered on the instrument is identified and calibrated into 16 individually selectable band-pass filtered ranges. Leak location is determined by internal processing techniques and displayed digitally; while other signal processing routines reject transients and steady stage "non-leakage" noises.

BALANCING

80-1937
Balancing of a Flexible Rotor
T. Nakai and S. Miwa
Aoyama-Gakuin Univ., Tokyo, Bull. JSME, 23 (176), pp 280-285 (Feb 1980) 7 figs, 7 tables, 9 refs

Key Words: Balancing techniques, Rotors (machine elements), Flexible rotors, Nonlinear programming

In the balancing of flexible rotors with overhung masses quadratic programming method is used for the calculation of magnitudes and angular positions of correction masses at selected planes. The effectiveness of this balancing procedure is illustrated by experiment.

80-1938
Rotor Model Parameter Estimation and Rotor Balancing Studies with Quadratic Programming
E.K. Woomer
Ph.D. Thesis, Univ. of Virginia, 133 pp (1979)
UM 8004602

Key Words: Rotors (machine elements), Parameter identification technique, Balancing techniques, Nonlinear programming

Three problems in rotor dynamics are studied: a method of estimation of unknown constants in a linear model of a rotor-bearing system is developed, the application of quadratic programming techniques to rotor-balancing is demonstrated, and a number of tests are evaluated for effectiveness in ranking the importance of balance weights in a many-weight distribution.

MONITORING

80-1939
Applying Wireless Data Coupling to Measurements on Moving Machinery
A.J. Adler
Acurex Corp., Mountain View, CA, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 319-330, 6 figs (Avail: see 80-1972)

Key Words: Monitoring techniques, Measuring instruments, Rotating structures

Wireless data coupling (short range telemetry) is used for making physical measurements on moving machinery. The technique employs miniature, highly ruggedized, radio transmitters which are mounted on moving machine components along with appropriate sensors, su as strain gages, thermocouples, or accelerometers.

80-1940
Selected Area Acoustic Emission Monitoring Using Nonvolatile Digital Memories
P.H. Hutton and J.R. Skorpik
Battelle Pacific Northwest Lab., Richland, WA, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 45-52, 8 figs, 15 refs (Avail: see 80-1972)

Key Words: Acoustic emission, Monitoring techniques, Fatigue life, Crack propagation

An acoustic emission monitoring system was developed which uses solid state digital memory to store acquired data in a permanent form that is easily retrieved.

80-1941
Vibration Standard for Power Transmission Equipment
R.L. Eshleman
Vibration Inst., Clarendon Hills, IL, Power Transm. Des., 22 (4), pp 26-29 (Apr 1980) 2 figs, 5 tables

Key Words: Power transmission systems, Standards

Vibration standards are a relatively new way to evaluate the conditions of power-transmission equipment. Coupled with simple vibration measurements, they help protect people, equipment, and production schedules.

ANALYSIS AND DESIGN

ANALOGS AND ANALOG COMPUTATION

(See No. 1862)

ANALYTICAL METHODS

(Also see Nos. 1807, 1861)

80-1942

Approximate Modal Analysis of Bilinear MDF

V. Tansirikongkol and D.A. Pecknold

URS/John A. Blume and Assoc., San Francisco, CA, ASCE J. Engr. Mech. Div., 106 (2), pp 361-375 (Apr 1980) 3 figs, 2 tables, 26 refs

Key Words: Modal analysis, Seismic response spectra, Multi-degree of freedom systems, Lumped parameter method

This paper describes two approximate response spectrum/modal analysis methods for dynamic response of hysteretic multi-degree-of-freedom lumped mass structural models subjected to earthquakes.

80-1943

A Theory of Index for Point Mapping Dynamical Systems

C.S. Hsu

Dept. of Mech. Engrg., Univ. of California, Berkeley, CA 94720, J. Appl. Mech., Trans. ASME, 47 (1), pp 185-190 (Mar 1980) 2 figs, 16 refs

Key Words: Dynamic systems, Nonlinear systems

Dynamical systems governed by discrete time-difference equations are referred to as point mapping dynamical systems in this paper. Based upon the Poincaré theory of index for vector fields, a theory of index is established for point mapping dynamical systems. Besides its intrinsic theoretic value, the theory can be used to help search and locate periodic solutions of strongly nonlinear systems.

80-1944

Acceleration Profiles for Minimizing Residual Response

D.M. Aspinwall

Lockheel Missiles & Space Co., Inc., Palo Alto Research Lab., Palo Alto, CA, J. Dyn. Syst., Meas. and Control, Trans. ASME, 102 (1), pp 3-6 (Mar 1980) 8 figs, 2 tables, 2 refs

Key Words: Pulse-shaping technique, Elastic media, Vibration control

A pulse-shaping technique based on a short, finite Fourier series expression for the forcing function is shown to attenuate residual dynamic response in elastic systems by several orders of magnitude. The approach is based on selecting the Fourier coefficients to depress the envelope of the residual response spectrum in desired regions. Response spectra comparisons are made for the rectangular, double versine, and shaped pulses.

80-1945

On the Simplification of Transfer Functions of Linear Dynamical Systems

T. Yahagi

Dept. of Electronic Engrg., Chiba Univ., Chiba, Japan, J. Dyn. Syst., Meas. and Control, Trans. ASME, 102 (1), pp 7-12 (Mar 1980) 1 fig, 3 tables, 4 refs

Key Words: Transfer functions, Linear systems, Dynamic systems

A method for the simplification of transfer functions of linear dynamical systems is presented. The sampled input and output data of the original system are used, and the least squares fit is applied to obtain a low-order model. This method is useful for obtaining a numerical solution on a digital computer.

80-1946

Analysis of Dynamic Systems Using Heuristic Optimization

N.A. Langrana and T.W. Lee

Mech. Industrial and Aerospace Engrg. Dept., Rutgers Univ., New Brunswick, NJ, J. Dyn. Syst., Meas. and Control, Trans. ASME, 102 (1), pp 35-40 (Mar 1980) 6 figs, 4 tables, 17 refs

Key Words: Optimization, Dynamic systems

An effective algorithm for the inverse dynamic problem is developed by combining the Heuristic Optimization Tech-

nique (HOT) with the Automated Assembly Program (AAPD). HOT is used to match the displacements; AAPD is used to generate equations of motion. Two problems are investigated. The first deals with a man-machine interaction system; the second deals with the spatial motion of a manipulator. The investigation demonstrates the potential application of the procedure in the analysis of dynamic systems of realistic complexity.

80-1947

Modal Identities for Elastic Bodies with Application to Vehicle Dynamics and Control

P.C. Hughes
School of Aeron. and Astron., Purdue Univ., West Lafayette, IN, J. Appl. Mech., Trans. ASME, 47 (1), pp 177-184 (Mar 1980) 5 figs, 13 refs

Key Words: Modal analysis, Spacecraft, Aircraft, Ships, Elastic media

It is a standard procedure to analyze a flexible vehicle in terms of its vibration frequencies and mode shapes. However, the entire mode shape is not needed per se, but two integrals of the mode shape which correspond to the momentum and angular momentum in mode. Together with the natural frequencies these modal parameters satisfy several important identities. Expansions in terms of both "constrained" and "unconstrained" modes are considered. A simple illustrative example is included. The paper concludes with some remarks on the theoretical and practical utility of these results, and several potential extensions to the theory are suggested.

80-1948

An Arbitrary Input Invariant Method of Time Domain Deconvolution

S.F. Pickett
Univ. of New Mexico, Civil Engrg. Res. Facility, Box 25, University Station, Albuquerque, NM 87131, Instrumentation in the Aerospace Industry - Vol. 25, Advances in Test Measurement - Vol. 16, Part 1, Proc. of the 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America: 1979, pp 193-198, 3 figs, 10 refs (Avail: see: 80-1972)

Key Words: Time domain method, Data processing

The time domain deconvolution method is applied for data reconstruction of a certain important class of systems.

80-1949

Variational Formulation of Nonconservative Circulatory Systems

M.S. El Naschie
Univ. of Riyadh, Saudi Arabia, Rev. Roumaine Sci. Tech. Mécanique, 24 (5), pp 731-735 (Sept/Oct 1979) 2 figs, 3 refs

Key Words: Stability, Variational methods, Elastic media, Follower forces

In this work attention is drawn to van Den Dungen's variational formulation of nonconservative systems. It is shown that this principle can be directly applied to generate the differential equation of motion governing the nonconservative stability behavior of elastic structures under follower forces.

80-1950

Equivalent Linearization for Hysteretic Systems under Random Excitation

Y.K. Wen
Dept. of Civil Engrg., Univ. of Illinois at Urbana-Champaign, Urbana, IL 61801, J. Appl. Mech., Trans. ASME, 47 (1), pp 150-154 (Mar 1980) 6 figs, 14 refs

Key Words: Equivalent linearization method, Hysteretic damping, Random excitation

A method of equivalent linearization for smooth hysteretic systems under random excitation is proposed. The hysteretic restoring force is modeled by a nonlinear differential equation and the equation of motion is linearized directly in closed form without recourse to Krylov-Bogoliubov technique. Compared with previously proposed similar methods, the formulation of the present method is versatile and considerably simpler. The accuracy of this method is verified against Monte-Carlo simulation for all response levels. It has a great potential in the analysis of multidegree-of-freedom and degrading systems.

80-1951

On the Singular Eigenfunctions for Plane Harmonic Problems in Composite Regions

G.B. Sinclair
Dept. of Mech. Engrg., Carnegie-Mellon Univ., Pitts-

burgh, PA 15213, J. Appl. Mech., Trans. ASME, 47 (1), pp 87-92 (Mar 1980) 7 figs, 12 refs

Key Words: Harmonic functions, Composites

This paper is concerned with the singular behavior of harmonic functions at the vertex of a plane, composite, wedge region. Separable harmonic functions which include logarithmic terms are investigated for their possible existence in the vicinity of the vertex. The eigenequations governing existence are examined and explicit determination of the singular eigenvalues made for several combinations of boundary and interface conditions. The results enable an appreciation of the possible singular nature in such problems which aids any complete (numerical) analysis.

80-1952

Mathematical Techniques for Acoustic Propagation Problems

P.E. Doak

Inst. of Sound and Vibration Research, Southampton Univ., UK, In AGARD Special Course on Acoustic Wave Propagation, 7 pp (Aug 1979)

N80-14862

Key Words: Boundary value problems, Elastic waves, Wave propagation, Transient response, Periodic response

The principal mathematical techniques for the solution of both steady state and transient acoustic propagation and boundary value problems, for both forced and free motion, are reviewed. These include separation of variables methods and the associated techniques for the resulting ordinary differential equations, Green function methods, Fourier, Laplace and other transform methods, finite element and other numerical methods, and certain special techniques including Wiener-Hopf. Emphasis is placed on the relative merits of the various methods for specific types of problems.

80-1953

Dynamic Green's Functions for Layered Media and Applications to Boundary - Value Problems

R.J. Apsel

Ph.D. Thesis, Univ. of California, San Diego, 374 pp (1979)

UM 8006878

Key Words: Green function, Boundary value problems, Seismic design, Viscoelastic media, Layered materials

A method to calculate three-dimensional dynamic Green's functions for layered viscoelastic media is developed. In seismology, these Green's functions may be used to synthesize theoretical seismograms for an extended source including the propagational effects of geologic layering. In earthquake engineering, these Green's functions may be used to determine the response of foundations to external forces and incoming seismic waves when embedded in realistic geologic structures. The formulation of the method and the subsequent application to problems in theoretical seismology are presented in Part I of this work. The formulation of an integral equation approach involving the Green's functions used to study boundary-value problems and the subsequent application to problems in earthquake engineering are presented in Part II of this work.

80-1954

On Approximate First Integrals of Hamiltonian Systems with an Application to Nonlinear Normal Modes in a Two Degree of Freedom Nonlinear Oscillator

L.A. Month

Ph.D. Thesis, Cornell Univ., 199 pp (1979)

UM 8003964

Key Words: Hamiltonian principle, Nonlinear theories, Approximation methods

Three methods for generating approximate first integrals of a Hamiltonian system are examined and compared: Whittaker's adelphic integral, Birkhoff-Gustavson normal form, and Lie transforms.

80-1955

Matrix Inverse Eigenvalue Problem for Periodic Jacobi Matrices

D.L. Boley and G.H. Golub

Dept. of Computer Science, Stanford Univ., CA, Rept. No. STAN-CS-78-684, 17 pp (Dec 1978)

N80-10855

Key Words: Eigenvalue problems, Matrix methods

A stable numerical algorithm is presented for generating a periodic Jacobi matrix from two sets of eigenvalues and the product of the off-diagonal elements of the matrix. The algorithm requires a simple generalization of the Lanczos algorithm. It is shown that the matrix is not unique, but the algorithm will generate all possible solutions.

80-1956

Stability of the Solutions to Mathieu-Hill Equations with Damping

P. Pedersen

Technical Univ. of Denmark, DK - 2800, Lyngby, Denmark, Ing. Arch., 49 (1), pp 15-29 (1980) 10 figs, 2 tables, 9 refs

Key Words: Hill equation, Damping coefficients, Galerkin method

The Mathieu-Hill equations with the addition of the damping term are treated directly, and not as an extended problem of the undamped case. To some extent this in fact simplifies the problem, and the basic theorems are derived without too much mathematics. The aim of the paper is to analyze the stability of the solutions, and this object is obtained by the Bubnov-Galerkin procedure, which is rather unused in relation to Mathieu-Hill equations.

80-1957

Bilinear Approximations of General Non-linear Dynamic Systems with Linear Inputs

S. Svoronos, G. Stephanopoulos, and R. Aris

Dept. of Chemical Engrg. and Materials Sci., Univ. of Minnesota, Minneapolis, MN 55455, Intl. J. Control, 31 (1), pp 109-126 (Jan 1980) 5 tables, 8 refs

Key Words: Nonlinear systems, Control equipment, Dynamic systems

Two methods are developed by which control systems that are non-linear in the state variables but linear in the inputs may be approximated by bilinear systems in the neighborhood of a steady state. For both methods the approximations can be made successively more accurate at the expense of higher dimensionality, and can be a considerable improvement over the linear approximation. The resulting dimensionalities are determined as functions of the accuracy. Illustrative examples are given, and finally the two models are compared.

80-1958

Optimum Experimental Design for Identi... ...ation of Distributed Parameter Systems

Z.H. Qureshi, T.S. Ng, and G.C. Goodwin

Dept. of Electrical Engrg., Univ. of Wollongong, P.O. Box 1144, Wollongong, N.S.W. 2500 Australia, Intl. J. Control, 31 (1), pp 21-29 (Jan 1980) 17 refs

Key Words: Parameter identification technique, Continuous parameter method

A method to design optimal experiments for parameter estimation in distributed systems is given. The design variables considered are the boundary perturbation and the spatial location of measurement sensors. The design criterion used is the determinant of Fisher's information matrix.

80-1959

The Characteristic Sequences Method for Multivariable Systems: A Time Domain Approach to the Characteristic Locus Method

B. Kouvaritakis and D. Kleftouris

Univ. of Bradford, Bradford, West Yorkshire, UK, Intl. J. Control, 31 (1), pp 127-152 (Jan 1980) 14 figs, 15 refs

Key Words: Time domain method

A time domain, input/output approach to the study of linear multivariable systems is developed. This approach leads to the characteristic sequence method which forms an extension of the characteristic locus method to the time domain.

80-1960

Component Mode Analysis of Nonlinear and Nonconservative Systems

E.H. Dowell

Dept. of Mech. and Aerospace Engrg., Princeton Univ., Princeton, NJ 08540, J. Appl. Mech., Trans. ASME, 47 (1), pp 172-176 (Mar 1980) 4 figs, 35 refs

Key Words: Component mode analysis

The use of Lagrange's equations and Lagrange multipliers to study the dynamics of interconnected systems in terms of their several components is extended to nonlinear and nonconservative systems.

MODELING TECHNIQUES

(Also see No. 1749)

80-1961

Remarks on the Static and Dynamic Imperfection-Sensitivity of Nonsymmetric Structures

I. Elishakoff
Dept. of Aerospace Engrg., Delft Univ. of Tech., Delft, the Netherlands, J. Appl. Mech., Trans. ASME, 47 (10), pp 111-115 (Mar 1980) 5 figs, 12 refs

Key Words: Dynamic buckling, Geometric imperfection effects

The simple static and dynamic buckling model (the three-hinge rigid-rod system, constrained laterally by a nonlinear spring) originally proposed by Budiansky and Hutchinson, is modified so that the force of the spring includes both quadratic and cubic terms. Expressions are given for the buckling load of the imperfect structure as function of the imperfection. These formulas generalize the classical expressions for the static buckling load (due to Koiter), and for the dynamic buckling load (due to Budiansky and Hutchinson) for symmetric or asymmetric structures, to nonsymmetric ones.

80-1962

Computer Simulation Model for the Prediction of Traffic Noise Levels

I.S. Diggory and B. Oakes
Dept. of Electrical Engrg. and Physical Electronics, Newcastle upon Tyne Polytechnic, Newcastle upon Tyne, UK, Appl. Acoust., 13 (1), pp 19-31 (Jan/Feb 1980) 10 figs, 3 tables, 5 refs

Key Words: Traffic noise

A computer simulation model for the prediction of traffic noise levels at intersections is described.

80-1963

Model Reduction of Dynamic Systems over a Frequency Interval

G. Langholz and Y. Bistritz
School of Engrg., Tel-Aviv Univ., Tel-Aviv, Israel, Intl. J. Control, 31 (1), pp 51-62 (Jan 1980) 3 figs, 11 refs

Key Words: Dynamic systems

Model reduction of linear, time-invariant, single-input, single-output systems over desired frequency intervals (low-pass, band-pass and high-pass) is considered. Order reduction is effected by manipulating two orthogonal polynomial series, one representing the high-order system and the other representing the approximating low-order model. The method is a generalization of the classical Padé approximations, however, by a special transformation it becomes the simple (classical) Padé problem, thus retaining the computational attractiveness of the latter.

NONLINEAR ANALYSIS

80-1964

The Method of Weighted Residuals in the Time Domain Applied to Nonlinear Vibrations

T. Ueda and Y. Matsuzaki
National Aerospace Lab., Tokyo, Japan, Rept. No. NAL-TR 564T, 8 pp (Mar 1979)
N80-12435

Key Words: Nonlinear response, Time domain method, Weighted residual technique

A method to solve nonlinear differential equations governing periodic motion is presented. The approximation is based on the method of weighted residuals. As an example problem, nonlinear vibrations of an infinitely long cylinder are examined, and their frequencies are calculated, using various types of assumed solutions and weighting functions. The numerical results show that the Galerkin type of finite element procedure gives a good approximation.

STATISTICAL METHODS

(Also see No. 1782)

80-1965

Probability of Response to Evolutionary Process

P.-T.D. Spanos and L.D. Lutes
Univ. of Texas, Austin, TX, ASCE J. Engr. Mech. Div., 106 (2), pp 213-224 (Apr 1980) 24 refs

Key Words: Probability density function, Damped structures

The probability density function of the response amplitude of a lightly damped linear oscillator subjected to a broad-band nonstationary process with evolutionary spectrum is examined. By using a combination of deterministic and stochastic averaging a one-dimensional diffusion equation is obtained that approximately governs the time evolution of the probability density function of the response amplitude. Based on the diffusion equation it is proved that the non-stationary probability density of the response amplitude can be approximated by a Rayleigh distribution with a time

dependent scaling variable. An equation for the analytical determination of the scaling variable is presented.

PARAMETER IDENTIFICATION

(Also see Nos. 1766, 1767, 1776, 1938)

80-1966

Robust Real-Time Algorithm for Identification of Non-linear Time-Varying Systems

M.R. Matausek and S.S. Stankovic

Faculty of Electrical Engrg., Univ. of Belgrade, Belgrade, Yugoslavia, Intl. J. Control, 31 (1), pp 79-94 (Jan 1980) 13 figs, 11 refs

Key Words: System identification techniques, Nonlinear systems

The paper presents a discussion on the problem of real-time tracking of time-varying parameters in nonlinear continuous-time system models on the basis of discrete-time noisy measurements. A recursive gradient-type output-error identification algorithm possessing high tracking capabilities has been derived by both optimizing a functional of the instantaneous error and introducing discontinuous sensitivity functions of the model output. The analysis of noise influence leads to the definition of a robust identification algorithm characterized by a nonlinear transformation of relay type applied to the increments of parameter estimates. Extensive simulation results illustrate the discussion and show the efficiency of the proposed robust algorithm even under high levels of noise.

80-1967

System Identification in Structural Dynamics: An Application to Wind Force Estimation

S.S. Simonian

Ph.D. Thesis, Univ. of California, Los Angeles, 225 pp (1979)
UM 8007449

Key Words: System identification techniques, Wind-induced excitation

The goal of this dissertation is dual in nature: the development and application of a general methodology addressing a class of inverse problems in science and engineering. The results developed here are applied to a particular inverse problem, namely the input force identification problem in structural dynamics.

80-1968

Structural Identification Using Linear Models and Earthquake Records

J.L. Beck and P.C. Jennings

Physics and Engr. Lab., DSIR, Lower Hutt, New Zealand, Intl. J. Earthquake Engr. Struc. Dynam., 8 (2), pp 145-160 (Mar/Apr 1980) 6 figs, 6 tables, 29 refs

Key Words: Parameter identification technique, Linear theories, Seismic response, Multistory buildings, Buildings

The problem of determining linear models of structures from seismic response data is investigated using ideas from the theory of system identification. The approach is to determine the optimal estimates of the model parameters by minimizing a selected measure-of-fit between the responses of the structure and the model. Because earthquake records are normally available from only a small number of locations in a structure, and because of noise in the records, it is necessary in practice to estimate parameters of the dominant modes in the records, rather than the stiffness and damping matrices of the linear model. A new algorithm is developed to determine the optimal estimates of the modal parameters. After tests with simulated data, the method is applied to a multi-story building using records from the 1971 San Fernando earthquake in California. New information is obtained concerning the properties of the lower modes of the building and the time-varying character of the equivalent linear parameters.

OPTIMIZATION TECHNIQUES

(See No. 1946)

DESIGN TECHNIQUES

(See No. 1899)

COMPUTER PROGRAMS

(Also see No. 1750)

80-1969

Digital Computer Solution of Aircraft Longitudinal and Lateral - Directional Dynamic Characteristics

J.M. Griffin, R.B. Yaeger, L.B. Jordan, and D.A. Ratino

Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH, Rept. No. AFFDL-TR-78-203, 173 pp (July 1979)
AD-A078-672/3

Key Words: Computer programs, Aircraft, Longitudinal response, Lateral response

Two computer programs are presented for the solution of aircraft longitudinal and lateral-directional transfer function factors and dynamic characteristics.

80-1970
Rotorcraft Flight Simulation, Computer Program C81. Volume III. Programmer's Manual.
P.Y. Hsieh
Bell Helicopter Textron, Fort Worth, TX, Rept. No. BHT-699-099-062, VOL-3, USARTL-TR-77-54C, 91 pp (Oct 1979)
AD-A077 345/7

Key Words: Computer programs, Helicopters, Flight simulation

This report consists of three volumes and documents the current version in the C81 family of rotorcraft flight simulation programs developed by Bell Helicopter Textron.

80-1971
Minicomputer Program Simulates Time-Response of Control Systems
K.E.J. Bowden
Control and Instrumentation, 11 (6), pp 71-73 (June 1979) 1 table

Key Words: Computer programs, Control equipment, Time-dependent excitation

A recently devised mini-computer program designed to simulate the time-response of control systems defined by their s-plane closed loop transfer functions is described.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

80-1972
Instrumentation in the Aerospace Industry - Volume 25. Advances in Test Measurement - Volume 16.
Proc. of 25th Intl. Instrumentation Symp. May 7-10, 1979, Anaheim, CA, Instrument Society of America, 400 Stanwix Street, Pittsburgh, PA 15222

The proceedings of this symposium, published in two parts, deal with the instrumentation needs of the transportation industries, machinery diagnostics, and energy research in addition to historic symposium topics. Individual papers dealing with the shock vibration and noise are abstracted in appropriate sections of this issue of SHOCK AND VIBRATION DIGEST.

TUTORIALS AND REVIEWS

80-1973
Literature Review - Automobile Ride Quality
C.C. Smith
University of Texas at Austin, TX, Shock Vib. Dig., 12 (4), pp 15-20 (Apr 1980) 33 refs

Key Words: Reviews, Automobiles, Ride dynamics

A brief review of the development of automobile ride quality over the past several years is presented; references that can be examined for further historical insight are given. Recent progress deals with passenger response prediction, vehicle motion prediction, and roadway surface modeling. Significant progress has been made, but the total automobile ride quality picture remains somewhat blurred. Significant need for continued development exists.

80-1974
Dynamic Analysis and Design - Challenge for the Future
R.W. Hager
Boeing Aerospace Co., P.O. Box 3999, MS 82-08, Seattle, WA 98124, Shock Vib. Dig., 12 (4), pp 3-12 (Apr 1980) 11 figs

Key Words: Reviews, Dynamic structural analysis

A review of the history of dynamic analysis and design through the past 49 sessions of the Shock and Vibration Symposia shows the significant progress made, and the problems and shortcomings being encountered today. Concerns and challenges for the future of dynamic analysis and design are discussed.

80-1975

Vehicle Structural Analysis: A Survey

G.H. Tidbury

School of Automotive Studies, Cranfield Inst. of Tech., UK, Intl. J. Vehicle Des., 1 (2), pp 165-172 (Feb 1980) 39 refs

Key Words: Reviews, Automobiles, Computer aided techniques, Design techniques, Collision research (automotive), Finite element technique

This survey examines structural analysis in automotive design developed in the past twenty years. Static and dynamic analysis of integral sheet metal car bodies are considered, as well as the problem of large deformations on impact. The theory of thin-walled beams in the design of ladder frames for commercial vehicles is emphasized.

80-1976

Special Course on Acoustic Wave Propagation

AGARD, Neuilly-Sur-Seine, France, Rept. No. AGARD-R-686, 226 pp (Aug 1979)
AD-A077 420/8

Key Words: Elastic waves, Wave propagation, Reviews

The special course dealt with the propagation of acoustic waves in inhomogeneous and moving media of both unlimited and finite extent. Recent theoretical and experimental work was reviewed, with particular emphasis on modeling of the phenomena involved and on prediction methods, as well as standardization aspects. The fundamental phenomena treated include: reflection, refraction, scattering, diffraction and attenuation. Measurement techniques and data analysis were also considered. Applications of the material presented occur in aeroacoustics, industrial acoustics and atmospheric propagation.

80-1977

Master Plan for Prediction of Vehicle Interior Noise

E.H. Dowell

Princeton Univ., Princeton, NJ, AIAA J., 18 (4), pp 353-367 (Apr 1980) 13 figs, 171 refs

Key Words: Reviews, Bibliographies, Aircraft noise, Noise prediction

This survey paper consists of a topical bibliography (171 refs) and a state-of-the art discussion.

80-1978

A General Survey of Studies on Acoustic Wave Propagation

M. Perulli

Office National d'Etudes et de Recherches Aerospatiales, Paris, France, AGARD Special Course on Acoustic Wave Propagation, 5 pp (Aug 1979)
N80-14859

Key Words: Elastic waves, Wave propagation, Reviews

A brief historical review of theoretical and experimental research in acoustic wave propagation is presented. Some of the different themes which must be addressed in order to increase the state of knowledge in this particular domain of acoustics concern propagation in ideal and nonideal media.

80-1979

A Summary and Evaluation of Semi-Empirical Methods for the Prediction of Helicopter Rotor Noise

R.J. Pegg

Langley Research Center, NASA, Hampton, VA, Rept. No. NASA-TM-80200, 96 pp (Dec 1979)
N80-15875

Key Words: Helicopter noise, Noise prediction

Existing prediction techniques are compiled and described. The descriptions include input and ouput parameter lists, required equations and graphs, and the range of validity for each part of the prediction procedures. Examples are provided illustrating the analysis procedure and the degree of agreement with experimental results.

80-1980

A Review of the Research at NTGE Concerning the Effects of Flight on Engine Exhaust Noise

W.D. Bryce

National Gas Turbine Establishment, Pyestock, UK, Rept. No. NGTE-R-78007; BR65126, 76 pp (Sept 1978)
N80-13887

Key Words: Aircraft noise, Engine noise

The problem of explaining the changes in engine exhaust noise when going from static to flight conditions has puzzled research workers for some years. Various experimental research programs which were carried out in regards to this topic over the last five years are reviewed.

CRITERIA, STANDARDS, AND SPECIFICATIONS

(See No. 1941)

BIBLIOGRAPHIES

(See No. 1977)

AUTHOR INDEX

TECHNICAL NOTES

G.R. Johnson, D.D. Colby, and D.J. Vavrick
Three-Dimensional Computer Code for Dynamic Response of Solids to Intense Impulsive Loads
Intl. J. Numer. Methods Engr., 14 (12), pp 1865-1871 (1979) 4 figs, 4 refs

S. Falk
Matrix Compensation by Means of the Least Squares Method and an Application to Damped Vibrations (Matrizenausgleich nach der Fehlerquadratmethode und eine Anwendung auf gedampfte Schwingungen)
Z. angew. Math. Mech., 59 (7), pp 329-331 (July 1979)
(In German)

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A Generalized View of Resonant Energy Transfer
J. Mech. Engr. Sci., 21 (4), pp 299-300 (Aug 1979)

H. Malsch
Calculation of Linear Vibrations by Means of Finite Space-Time Elements
Z. angew. Math. Mech., 59 (9), pp 474-477 (Sept 1979) 4 figs, 1 table, 4 refs

K. Gopalsamy
Vibrating Systems under Space-Time Stochastic Loads
Z. angew. Math. Mech., 59 (9), pp 477-479 (Sept 1979) 9 refs

A.P. Bhattacharya
Free Vibration of Ring-Sector Plates of Variable Rigidity
Aeronaut. J., 83 (826), pp 309-401 (Oct 1979)

M.J. O'Rourke and G. Kountouris
Floor Response Spectra for Equipment
ASCE J. Engr. Mech., Div., 105 (EM5), pp 907-911 (Oct 1979) 3 refs

I. Nelson
Axial Vibrations of Fluid Filled Pipe
ASCE J. Engr. Mech. Div., 105 (EM5), pp 901-906 (Oct 1979) 2 figs, 4 refs

V.K. Singh and S. Rawtani
Vibration Frequencies of a Twisted Uniform Blade with One End Spring Hinged and the Other Free
J. Engr. Power, Trans. ASME, 101 (4), pp 679-680 (Oct 1979) 3 figs, 4 refs

P. -T.D. Spanos and T.W. Chen
Linearization Equations for Vibration Induced by Oscillatory Flow
J. Appl. Mech., Trans. ASME, 46 (4), pp 946-948 (Dec 1979) 2 figs, 8 refs

A.I. Beltzer
Response of a Rigid Sphere Embedded in an Elastic Medium to Random Disturbances
J. Appl. Mech., Trans. ASME, 46 (4), pp 951-952 (Dec 1979) 1 fig, 4 refs

E.L. Mello and J. Munro
On the Eigenproblem Formulation of Static Structural Problems
Eng. Struct., 2 (1), pp 63-64 (Jan 1980) 5 refs

W. Kellenberger
Spiral Vibrations Due to the Seal Rings in Turbogenerators Thermally Induced Interaction Between Rotor and Stator
J. Mech. Des., Trans. ASME, 102 (1), pp 177-184 (Jan 1980) 10 figs, 4 refs

L.N. Krause and G.C. Fralick
Some Dynamic and Time-Averaged Flow Measurements in a Turbine Rig
J. Engr. Power, Trans. ASME, 102 (1), pp 223-224 (Jan 1980) 3 figs, 5 refs

J.M. Anderson
Power Measurement for Frequencies up to 1 GHz Using a Sampling Oscilloscope and a Low-Frequency Multiplier
Rev. Scientific Instr., 51 (1), pp 145-146 (Jan 1980)

M.R.M.C. da Silva
On the Whirling of a Base-Excited Cantilever Beam
J. Acoust. Soc. Amer., 67 (2), pp 704-707 (Feb 1980) 3 figs, 15 refs

CALENDAR

AUGUST 1980

18-21 International Lubrication Conference [ASME - ASLE] San Francisco, CA *(ASME Hq.)*

SEPTEMBER 1980

2-4 International Conference on Vibrations in Rotating Machinery [IMechE] Cambridge, England *(Mr. A.J. Tugwell, Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ, UK)*

8-11 Off-Highway Meeting and Exposition [SAE] MECCA, Milwaukee, WI *(SAE Hq.)*

14-16 ASME Petroleum Division Conference and Workshop [ASME] Denver, CO *(ASME Hq.)*

28-Oct 1 Design Engineering Technical Conference [ASME] Beverly Hills, CA *(ASME Hq.)*

OCTOBER 1980

Stapp Car Crash Conference [SAE] Detroit, MI *(SAE Hq.)*

6-8 Computational Methods in Nonlinear Structural and Solid Mechanics [George Washington University & NASA Langley Research Center] Washington, D.C. *(Professor A.K. Noor, The George Washington University, NASA Langley Research Center, MS246, Hampton, VA 23665 - (804) 827-2897)*

14-15 Textile Engineering Technical Conference [ASME] Atlanta, GA *(ASME Hq.)*

21-23 51st Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, D.C.] San Diego, CA *(Henry C. Pusey, Director, SVIC, Naval Research Lab., Code 5804, Washington, D.C. 20375)*

27-31 ASCE Annual Convention & Exposition [ASCE] Hollywood, FL *(ASCE Hq.)*

28-30 Eastern Design Engineering Show [ASME] New York, NY *(ASME Hq.)*

NOVEMBER 1980

16-21 ASME Winter Annual Meeting [ASME] Chicago, IL *(ASME Hq.)*

18-21 Acoustical Society of America, Fall Meeting [ASA] Los Angeles, CA *(ASA Hq.)*

DECEMBER 1980

Aerospace Meeting [SAE] San Diego, CA *(SAE Hq.)*

8-10 INTER-NOISE 80 [International Institute of Noise Control Engineering] Miami, FL *(INTER-NOISE 80, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 12603)*

9-11 Western Design Engineering Show [ASME] Anaheim, CA *(ASME Hq.)*

MARCH 1981

8-12 26th International Gas Turbine Conference and Exhibit [ASME] Houston, TX *(ASME Hq.)*

21-Apr 1 Lubrication Symposium [ASME] San Francisco, CA *(ASME Hq.)*

APRIL 1981

6-8 22nd Structures, Structural Dynamics, and Materials Conference [AIAA, ASME, ASCE, AHS] Atlanta, Georgia *(AIAA, ASME, ASCE, AHS Hqs.)*

MAY 1981

4-7 Institute of Environmental Sciences' 27th Annual Technical Meeting [IES] Los Angeles, CA *(IES, 940 East Northwest Highway, Mt. Prospect, IL 60056)*

JUNE 1981

1-4 Design Engineering Conference and Show [ASME] Chicago, IL *(ASME Hq.)*

22-24 Applied Mechanics Conference [ASME] Boulder, CO *(ASME Hq.)*

SEPTEMBER 1981

20-23 Design Engineering Technical Conference [ASME] Hartford, CT *(ASME Hq.)*

OCTOBER 1981

Eastern Design Engineering Show [ASME] New York, NY *(ASME Hq.)*

4-7 International Lubrication Conference [ASME - ASLE] New Orleans, LA *(ASME Hq.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass. Ave., N.W.
Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto, Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 5804
Washington, D.C. 20375

URSI-USNC: International Union of Radio Science - U.S. National Committee
c/o MIT Lincoln Lab.
Lexington, MA 02173